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A REVISION OF THE GENUS VESICULAPHIS DEL GUERCIO, WITH DESCRIPTIONS OF FOUR NEW SPECIES (HOMOPTERA: APHIDIDAE)

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Species of the genus *Vesiculaphis* described so far in the world are reviewed. Of a total of 11 species described by authors, 8 are accepted as representatives of the genus: *caricis* (Fullaway), *kongoensis* Takahashi, *theobaldi* Takahashi, *cephalata* Miyazaki, *samagaltaica* (Ivanovskaja-Shubina), *pieridis* Basu, *grandis* Basu and *rhododendri* Ghosh et al. The remainder are transferred to other genera: *verbasci* Chowdhuri et al. to *Myzakkaia*, *kuwanais* Ghosh et al. to *Myzakkaia* (comb. n.) and *kalimpongensis* Ghosh et al. to *Myzus* (comb. n.). Four species are described from Japan as new to science: *caerulea*, *rotunda*, *nubilimaculata* and *angusticeps*. The alate viviparous female of *cephalata* is described for the first time. As the result 12 species are placed in the genus. These species are divided into 3 groups, and the phylogenetic relationship among them is discussed with special reference to the chaetotaxy and frontal extrusion of the head. Host association and geographical distribution of the genus are summarized. Key to the species is provided for apterae and alatae.

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INTRODUCTION

The genus *Vesiculaphis* was erected by del Guercio (1911) with *Toxoptera caricis* Fullaway, 1909, as the type-species. The genus may be readily recognized by the aptera, of which the frontal part of the head is strongly produced forward to form a conspicuous ledge. Later, Theobald (1922) erected *Trilobaphis* for the reception of a new species, *T. caricis* Theobald, which is characterized by the head of the aptera bearing 3 lobe-like projections on the front.

Although some authors accepted *Trilobaphis* as a good genus (Heinze, 1961 and 1972; Ivanovskaja, 1977), the opinion that *Trilobaphis* and *Vesiculaphis* are one and the same taxon seems now prevailing (Eastop, 1956; Szelegiewicz, 1968; Miyazaki, 1971; Paik, 1972; Ghosh et al., 1976; Eastop and Hille Ris Lambers, 1976). The 2 species mentioned above had long been the only representatives of the genus *Vesiculaphis* in this sense, until as many as 9 other species were described from Asia in this decade or thereabouts. This genus may be defined rather sharply by the peculiar shape of the head of apterae as stated above. Recent additions of species, however, made the taxonomic concept of the genus ambiguous. Miyazaki (1971) has given an account of the Japanese species and Ghosh et al. (1976) have done of the Indian ones, but it would be seen that their concepts of the genus are not harmonious with each other in some respects. It is one of the aims of the present paper to propose an opinion concerning the taxonomic status of the genus.

In the course of the present study, a lot of specimens have been examined including those preserved in the collection of Entomological Institute of Hokkaidô University. In addition, I have examined the type-specimens or authentically identified specimens of the species concerned except *V. samagaltaica* from Tubinskaja, USSR. As a result of the present study, 8 out of 11 described species are referred to *Vesiculaphis*, and the remaining 3 to other genera. On this occasion 4 other species will be described from Japan as new to science. The syntypes of the new species are deposited in the Entomological Institute, Hokkaidô University, and in the Insect Taxonomy Laboratory, NIAS.

TAXONOMY AND PHYLOGENY

It is Takahashi (1930) who first pointed out that *Trilobaphis* should be suppressed as a synonym of *Vesiculaphis*. His conclusion was apparently based on the apterae, because the alate form of *caricis* Theoblad, the type-species of *Trilobaphis*, was not found yet at that time. Eastop (1956) agreed with Takahashi on the basis of the alatae. The view may also be supported by the evidence in the cephalic chaetotaxy.

The supposed basic arrangement of the cephalic setae in Aphididae is presented in fig. 1A, where the dorsal setae are tentatively named for discussion. Compared with this pattern, *Vesiculaphis* (fig. 1C & D) is peculiar by AD and MD shifted to the laterofrontal part of the head, where they are located very close to each other.

Fig. 2 is a diagrammatical presentation summarizing the view adopted here in regard to the evolutionary trend in the cephalic morphology and chaetotaxy of *Vesiculaphis*. The species dealt with in the present paper are divided into 3 groups: the *caricis*-group substantially corresponds to *Vesiculaphis* in a strict sense and the *theobaldi*-group to *Trilobaphis* in the sense of Theobald (1922); *pieridis* and its close relatives, all described from Ericaceae in India, are put together in the *pieridis*-

group. The *pieridis*-group is very similar to liosomaphidine genera in the following characters of the head: the frontal part is gently concave without any trace of extrusion into a ledge; the median tubercle is recognizable as a low swelling situated slightly more ventrally than usual; the antennal tubercles are weakly developed; dorsal setae essentially follow the basic pattern, but MD and PD_O are located slightly more forward than usual (fig. 1B).

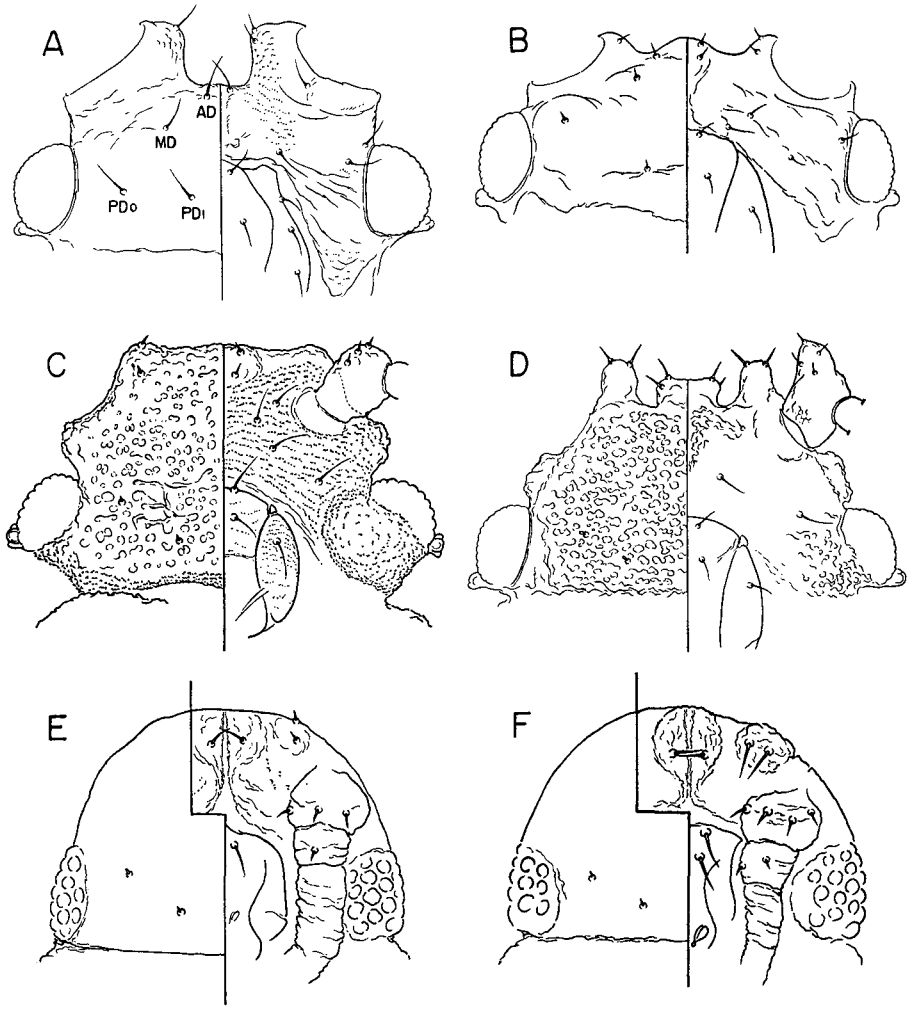

Fig. 1. The head of the apterous viviparous female (A–D) and embryo (E & F). In each figure the left side shows the dorsal surface and the right side the ventral surface. A: *Amphorophora filipendulae* Miyazaki showing the supposed basic arrangement of dorsal setae. The setae are named AD (anterior discals), MD (middle discals), PD_I (inner pair of post discals) and PD_O (outer pair of post discals). B: *Liosomaphis ornata* Miyazaki as a representative of the liosomaphidine genera. C: *Vesiculaphis caricis* (Fullaway). D: *Vesiculaphis cephalata* Miyazaki. E: *Vesiculaphis caerulea*, sp. n. F: *Vesiculaphis cephalata* Miyazaki. (The figures A, B and D are taken from Miyazaki, 1971, with a slight modification).

In the apterae of the *caricis*-group the cephalic shield is extruded anteriorly and laterally (before eyes) to form a ledge over the antennal bases (fig. 1C). The formation of such a ledge is associated with the drift of AD and MD toward the laterofrontal portion of the cephalic shield, where the frontal extrusion is especially pronounced, and where AD and MD are located very close to each other. The frontal ledge is nearly straight-edged or very gently wavy when seen from above in *caricis*, but it is more pronounced laterally in *caerulea* (fig. 7A), and still more conspicuously in *rotunda* (fig. 8A). Consequently, AD and MD still retain the longitudinal sequence in their arrangement in *caricis*, while in *caerulea* and *rotunda* they are located so closely and sometimes arranged even transversely.

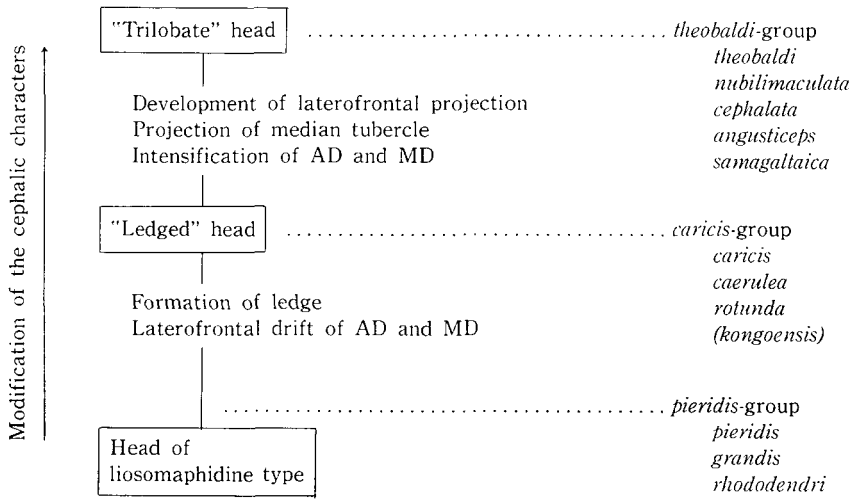

Fig. 2. Diagrammatical presentation of the evolutionary trend in the cephalic characters of the apterae in the genus *Vesiculaphis*. (*V. kongoensis* is known by the alata only).

In the *theobaldi*-group, the lateral rise of the frontal ledge is much more conspicuous as the laterofrontal projections (fig. 1D). AD and MD are now placed side by side at the apex of the projections, their longitudinal sequence having been totally lost. At the same time, the median tubercle is produced to form a median projection. In *nubilimaculata* and *samagaltaica* the median projection is much lower than the laterofrontal ones (fig. 9A), and may be considered to represent an intervenient state. The fully developed median projection is found in *theobaldi*, *cephalata* and *angusticeps*, where it is as high as the laterofrontal projections. In the *theobaldi*-group AD and MD are very long and thick while PD_I and PD_O remain minute. Such an increase of setal size is also seen for the setae of the median tubercle.

In the fundatrix and the alata, so far as known, the modification of the cephalic characters is less prominent, the frontal ledge (or laterofrontal projections) being much lower in the fundatrix than in the aptera and not or only slightly developed in the alata. The longitudinal sequence of AD and MD may be recognized more clearly. The modified chaetotaxy is seen as early as the embryonic stage (fig. 1E & F).

In conclusion, according to the view adopted here, the extrusion of the cephalic shield and the accompanying modifications which are fully developed

in the *theobaldi*-group may be traced back through the *caricis*-group to the more primitive state in the *pieridis*-group. The projection of the median tubercle itself is visible in variable degree in various macrosiphine genera such as *Myzaphis*, *Aspidophorodon*, *Rhodobium*, etc. So far as I know, however, the formation of a ledge and the conspicuous forward drift of cephalic setae are unique to the species belonging to the *caricis*- and the *theobaldi*-group as understood here. This may take part with the opinion that these two groups, hence *Vesiculaphis* s. str. and *Trilobaphis*, belong to the same taxonomic unit as Takahashi (1930) and Eastop (1956) already pointed out. The *pieridis*-group stands rather apart from both of them in that no trace of the ledge formation and chaetotactic shift on the head is detected. In the present paper, I prefer to tentatively follow Eastop and Hille Ris Lambers (1976) in including the *pieridis*-group in *Vesiculaphis* on the basis of other morphological characters and the host association with Ericaceae.

Host association

The life history of each species of *Vesiculaphis* largely remains unknown. Only 2 species, *caricis* and *theobaldi*, have been studied of their life cycle. *V. caricis* is heteroecious, completing its life cycle by migrating between azaleas (Ericaceae) as the primary host and sedges (Cyperaceae) as the secondary one. *V. theobaldi*, on the other hand, is known to be a monoecious species. It lives on sedges throughout the year, either holocyclically or anholocyclically. The monoecious type life cycle represented by *theobaldi* may well be considered to have been derived from the heteroecious one represented by *caricis* through a segregation of a part of the heteroecious sequence to form a separate cycle completed only on the originally secondary host plant. Speculation on such an evolutionary sequence in aphids' life cycles has been presented by Hille Ris Lambers (1939 & 1950), and an example in the adelgid genus *Sacchiphantes* has also been given by Steffan (1961).

V. pieridis seems to have a third type of life cycle: judging from the collecting data recorded by several authors, at least a part of the population of this species most likely spends a monoecious and anholocyclic type of life cycle on *Pieris* (Ericaceae), which is comparable with the primary host in the heteroecious type of cycle. The whole picture of the host association of *pieridis* and its relatives is important for considering their systematic position.

The other species that are recognized in the present paper as belonging to *Vesiculaphis* have so far been recorded either from an azalea (*V. kongoensis*) or from sedges (*V. caerulea*, *rotunda*, *cephalata*, *nubilimaculata* and *angusticeps*). Their host association in the whole life cycle is, however, yet to be explored.

Some species have been described under *Vesiculaphis* with host plants belonging to neither Ericaceae nor Cyperaceae: *V. verbasci* was described from *Verbascum* (Scrophuraliaceae) and *Polygonum* (Polygonaceae); *V. kalimpongensis* was described from *Artemisia* (Compositae). After my close examination of specimens of these species, I have come to the conclusion that they should be transferred to other genera, *verbasci* to *Myzakkaia* and *kalimpongensis* to *Myzus*.

Under the circumstances described above, one may be led to the conclusion that *Vesiculaphis* is essentially associated with Ericaceae as the primary host and with Cyperaceae as the secondary host, with some species having acquired a monoecious life cycle on either of the mentioned plant families.

GEOGRAPHICAL DISTRIBUTION

Of the species dealt with in this paper, *caricis* and *theobaldi* are rather widely distributed. *Caricis* is known from the Far East and Southeast Asia, and is also recorded from Hawaii and North America. On the other hand, *theobaldi* is distributed in the central and western part of Europe. Little is known on the distributional range of other species, which are known so far from restricted localities in Asia.

It should be remembered here that the *theobaldi*-group is considered to be advanced in a series of modifications in the cephalic characters as compared with the *caricis*-group (vide ante). In addition, *theobaldi* is the only representative of the genus in Europe, while in Asia there occur various species of the *caricis*-group as well as those belonging to the *theobadli*-group. These evidences may favour the opinion that the genus *Vesiculaphis* has its origin somewhere in the eastern part of Eurasian continent. This may also lead one to conclude that *caricis* was introduced, perhaps by human agency, to Hawaii and North America from Asia.

TAXONOMIC ACCOUNTS

Genus *Vesiculaphis* del Guercio

Vesiculaphis del Guercio, Redia 7: 463, 1911. [Type-species: *Toxoptera caricis* Fullaway, 1910].

Trilobaphis Theobald, Ent. mon. Mag. 58: 137, 1922. [Type-species: (*Trilobaphis caricis* Theobald, 1922) = *Vesiculaphis theobaldi* Takahashi, 1930].

Pentaceratinaphis Ivanovskaja-Shubina, Acad. Sci. USSR, Siberian Branch, Inst. Biol. 1965: 59. [Type-species: *Pentaceratinaphis samagaltaica* Ivanovskaja-Shubina, 1965].

The genus *Vesiculaphis* as understood here may be defined morphologically by the combination of the following characters.

Apterous viviparous female: Head flattened, extruded anteriorly and laterally to form a ledge hanging over the antennal tubercle which is very low; the ledge on frontal part rather uniformly produced (in *caricis*-group) or strongly protruded on either side to form laterofrontal projections (in *theobaldi*-group), and on lateral part just before eye protruded into a small triangular or rectangular prominence; median tubercle slightly shifted ventrally, lightly swelling (in *caricis*-group) or protruded into a rectangular process (in *theobaldi*-group); of dorsal setae, the anterior discals and the middle discals are shifted onto laterofrontal portion of frontal ledge (in *caricis*-group) or onto apex of laterofrontal projection (in *theobaldi*-group). These peculiarities of the head are, however, lacking in the *pieridis*-group. Antenna without secondary rhinaria. Prothorax with 2 pairs of mesial setae, one pair of them being located anteriorly and the other posteriorly. Abdomen with sclerotized terga; 6th segment reduced marginally, so that the siphunculi look as if they are on the 6th segment; 8th segment semicircular or triangular, defined from foregoing segments which are consolidated. Siphunculus bent slightly in an S-shape, mostly cylindrical with attenuated apex, usually imbricated with large scales outwardly and scabrous with fine denticles inwardly. Cauda often reticulated apically.

In the larva the hind tibia is densely and strongly spinulated. In the alate viviparous female the frontal ledge is hardly developed or only discernible as small protuberances, with the lateral prominence before the eye not developed; the

antenna bears elevated oval rhinaria on the 3rd–5th (sometimes also 6th) segments; the abdomen is either with or without sclerotic bands on anterior segments.

Caricis-group

1. *Vesiculaphis caricis* (Fullaway) (Fig. 1C; Plate I, Fig. 3C; Plate IV, Fig. 6).

Toxoptera caricis Fullaway, Hawaii Agr. Exp. St. Rept. (1909): 32, 1910.

Vesiculaphis caricis: Takahashi, Agr. Exp. St., Govt. Formosa, Rept. 20: 30, 1921; Uye, Insect World 29(336): 254, 1925; Shinji, Monogr. Jap. aphid. p. 695, 1941; Tao, Sci. Yearbook Taiwan Mus. 7: 128, 1964; Miyazaki, Ins. matsum. 34(1): 96, 1971; Paik, Illustrated Encyclopedia of Fauna and Flora of Korea 13: 549, 1972.

Toxoptera rhododendroni Uye, Insect World 27(305): 3, 1923.

Toxoptera Shichito Uye (sic), Insect World 27(305): 3, 1923.

Specimens examined*: 6 apterous viviparous females (syntypes of *Toxoptera caricis* Fullaway) on 2 slides with labels which read: Haw. Agr. Exp. Sta., on sedge, *Carex* sp. ?, Pauoa V. (1500–2000 m.), Oahu, T.H., May 21, 1907, D. T. Fullaway leg. A fundatrix and an alate viviparous female, Angel's Camp, Calaveras Co., California, USA, 9–v–1961, ex azalea, Allen-Blanc leg. A lot of specimens from the following localities in Japan. Fundatrices: – Nishinasuno, Tochigi Pref. (2–v–1974, ex *Rhododendron kaempferi*); Fukuoka, Fukuoka Pref. (1–v–1965, ex *Rhododendron* sp., H. Takada leg.); Miyakonojo, Miyazaki Pref. (15–v–1965, ex *R. kaempferi*). Emigrants: – Fukuoka and Miyakonojo (as above). Apterous alienicolae: – Nishinasuno (21–ix & 30–x–1973, ex *Cyperus brevifolius* var. *leiolepis*, and 1–viii & 7–ix–1976, ex *Cyperus microiria*); Katsurakoba, Ina-shi, Nagano Pref. (29–viii–1970, ex *C. brevifolius* var. *leiolepis*); Chikugo-shi, Fukuoka Pref. (18–x–1972, ex *Cyperus serotinus*, O. Mochida leg.). Immigrants: – Nishinasuno (30–x–1973, ex *C. brevifolius* var. *leiolepis*); Chikugo-shi (as above). Sexuales (males and oviparous females): – Nishinasuno (30–xi–1973, ex *R. kaempferi*).

Host plants: This species takes *Rhododendron* as the primary host and Cyperaceae as the secondary host. In Japan it is known as an important pest of the "Shichito" sedge, *Cyperus monophyllus*. A heavy infestation of the aphid may greatly reduce the yield of the sedge, and the black mold growing on the honeydew excreted by the aphid destroys the market value. It is Uye (1925) who first reported the migration of the aphid between azaleas (*Rhododendron* spp.) and the "Shichito" sedge. I also confirmed that the aphid migrates between *Rhododendron kaempferi* and *Cyperus brevifolius* var. *leiolepis* at Nishinasuno.

This species was originally described from *Carex* sp. in Hawaii. But in Japan, the alienicolae of the species have so far been recorded only from *Cyperus* spp. According to Uye's (1925) observation in Kyûshû, the alienicolae build up dense colonies on *Cyperus monophyllus*, from which they may move to some other *Cyperus* spp. In the present study, *Cyperus microiria* and *C. serotinus* in addition to *C. brevifolius* var. *leiolepis* are recognized as hosts in Japan. In Taiwan and India the aphid was recorded from *Cyperus rotundus* (after Takahashi, 1921, Tao, 1964, and Basu, 1969). In Korea and N. America it is known only from *Rhododendron*, and the alienicolae have not yet been recorded.

Taxonomic notes: The difference in the host association stated above may

* Specimens from Japan were collected by me unless otherwise stated.

induce doubt as to the identification of the Japanese form with *V. caricis*. In morphological characters, however, the specimens at hand from *Cyperus* in Japan agree quite well with the syntypes of the species. In this regard the collecting data attached to the syntype slides (vide ante) may cause some doubt in the host record in the original description.

Geographical distribution: Japan (Hokkaidô, Honshû and Kyûshû); Korea (after Paik, 1972); Taiwan (after Takahashi, 1921, and Tao, 1964); India (after Basu, 1969, and Hille Ris Lambers, in litt.); Hawaii; USA (California; Eastern States, after Leonard and Bissell, 1970, and Smith and Parron, 1978).

2. *Vesiculaphis caerulea*, sp. n. (Plate II, Fig. 4A; Plate V, Fig. 7; Table 1)

Apterous viviparous female. Body oval and flat, in life light green with head and thorax dark blue; abdomen often mottled with bluish green; antennae, legs, siphunculi and cauda pale. In mounted specimens body about 1.2 mm. long and 0.7 mm. wide.

Head nearly smooth dorsally except for spinulous hind margin; ventral surface spinulous; frontal area markedly protruded forward into a ledge, so that the distance between the antennal socket and the frontal line is longer than that between the antennal socket and the eye; the ledge is smooth ventrally or at most scabrous on its basal half; laterofrontal portion of the ledge produced into a swelling low but distinct, roundly angulate, and with 2 minute setae apically (in some cases with only one visible seta); median tubercle wrinkled, situated on ventral side of head, much lower than laterofrontal swellings when seen from above, with 4 stiff setae; dorsal shield triangularly protruded laterally before eyes, with a pair of areolations mesially, with 2 pairs of minute setae posteriorly; ventral setae 4–6 in number on each side, up to 1.5 times as long as middle width of 3rd antennal segment, with drawn-out apices; antennal tubercle with a midventral seta. Eyes prominently swelling inwards ventrally; triommatidion well developed. Antennae about 0.4–0.5 as long as body, 5-segmented; 1st segment spinulous, rounded at inner apex, the articulation to 2nd segment being strongly oblique, swelling dorsally on apical half, little angulated at inner margin, with some pointed or blunt setae at most 2/3 as long as middle width of 3rd antennal segment; 2nd imbricated,

Table 1. Biometric data for *Vesiculaphis caerulea*: apterous viviparous female (N=6). Range and mean (in parentheses) are given in mm.

Body: L	1.15–1.25 (1.22)	Siphunculus: L	0.28 –0.30 (0.29)
W	0.68–0.73 (0.70)	W at middle	0.043–0.053 (0.046)
Head: L	0.18–0.20 (0.19)	Cauda: L	0.081–0.090 (0.086)
W across eyes	0.34–0.36 (0.35)	W	0.050–0.058 (0.054)
Cephalic shield: W	0.26–0.29 (0.27)	Ult. rost. seg.	0.048–0.055 (0.051)
Antenna: L (whole)	0.50–0.58 (0.54)	Hind tarsal II	0.043–0.048 (0.046)
Seg. III	0.16–0.18 (0.17)	Setal length maxima on:	
Seg. IV	0.06–0.09 (0.07)	median tubercle (head)	0.015–0.020 (0.018)
Base V	0.07–0.08 (0.07)	latero-frontal projection (head)	0.006–0.011 (0.009)
Proc. term.	0.11–0.15 (0.13)	cephalic disc }	minute and
Hind femur	0.23–0.26 (0.24)	abdominal disc }	unmeasurable
Hind tibia	0.38–0.42 (0.39)	abdominal VIII	0.003–0.007 (0.005)

Abbreviations. L: length; W: width; Proc. term.: processus terminalis; Ult. rost. seg.: ultimate segment of rostrum.

with 3 setae; 3rd nearly smooth or weakly serrated mesially; processus terminalis 1.50–2.15 times as long as basal part of 5th; 3rd–5th in proportion of 100:39:42+73 in length. Clypeus sparsely spinulous, with 2 setae anteriorly; mandibular lamina spinulous, with a seta. Rostrum reaching between fore and middle coxae; ultimate segment parallel-sided or slightly tapering, about 1.3 times as long as wide, 1.10–1.11 times as long as 2nd segment of hind tarsus, with 0–2 secondary setae. Femora spinulous ventrally, the spinules becoming sparser from fore to hind femur. Tibiae with some imbrications in hind legs and usually also in middle legs (fore tibiae smooth), with sparse setae, of which the longest one is 1/2–3/4 as long as the middle width of the hind tibia. First tarsal chaetotaxy 3:3:2; sense pegs about as long as lateral setae; 2nd tarsal segment without secondary setae. Mesosternal furca with arms separated from each other. Abdominal tergites pale, consolidated into a shield except for a semicircular plate representing the 8th tergite, with dull mosaic-like wrinkles anteriorly; 7th and 8th tergites imbricated with denticles; intersegmental areolations in a few ill-defined facets, often hardly discernible. Dorsal setae of abdomen minute and blunt; their arrangement is as follows: – anterior 4 tergites with 5–9 setae besides marginal ones which are 2 (sometimes 1) in number on each side; 5th with 4 setae spinopleurally, usually without marginal setae; 6th with 2 setae mesially; 7th with 2 setae posteromarginally; 8th with 4 setae. Abdominal sternites with rows of fine and weak spinules mesially, strongly and densely spinulous marginally except for narrow zones of intersegmental areas smooth; ventral setae pointed and minute, at most about 7 μ in length. Siphunculus cylindrical, slightly broadened and bent inwards at base, attenuated at apex but not so abruptly as in *caricis* and *rotunda*, 5.37–6.41 times as long as wide at middle, much shorter than head width across eyes; the width at middle 2.00–2.85 times the narrowest part below flange; dorsal surface weakly corrugated; ventral surface with denticulate imbrications, which are obsolete on outer 1/3–1/2 of the surface, so that the inner margin of siphunculus is strongly serrate while the outer surface is very weakly terraced or nearly smooth. Cauda 1.50–1.80 times as long as wide, about 1/3 as long as siphunculus, attenuated at apical half, round at apex, with 4 setae, and with spinules forming areolations apically. Genital plate oval, with 2 setae anteriorly, 2 setae at middle, and 2–4 setae posteriorly.

Specimens examined: 6 apterous viviparous females (syntypes), Komaganekôgen, Komagane, Nagano Pref., 1–ix–1970, ex *Carex* sp. (coll. no. 2795). In addition, 2 apterous viviparous females and an alatoid nymph were collected from Mt. Norikura (near Hirayu), Gifu Pref., 8–ix–1970, ex *Carex* sp. (coll. no. 2867).

Host plants: *Carex* spp. This aphid infests the undersurface of the leaves.

Taxonomic notes: This species is well characterized by the compound eye with a marked ventromesial swelling. In addition, the combination of the following characters makes it easy to recognize the species: – Head with laterofrontal prominences conspicuous, though they are not produced into thumb-like projections; clypeus with only 2 setae anteriorly; body integument quite colourless in mounted specimens; siphunculus gently attenuating apically and not densely spinulated mesially; body of unique colouration in life.

3. *Vesiculaphis rotunda*, sp. n. (Plate II, Fig. 4B; Plate VI, Fig. 8; Table 2)

Apterous viviparous female. Body roundly oval; ground colour in life pale green; thoracic and abdominal terga blackish brown to black except 7th and 8th abdominal tergites which are pale; head brownish, darkened posteriorly. Antennae,

legs, siphunculi and cauda pale. Eyes blackish brown. In mounted specimens body about 1.3 mm. long and 0.8 mm. wide. Larvae pale yellowish brown; head posteriorly and prothorax brown.

Head pale brown in cleared specimens, finely warty dorsally, spinulous over venter and along hind margin of dorsum, with 2 pairs of minute blunt setae on dorsal disc, usually with 2 pairs of pointed setae ventrally, which are about 1.3 times as long as middle width of 3rd antennal segment; dorsal shield projecting laterally in a triangular form just before eye; front protruded into a ledge, the lateral parts of which are roundly angulate, much higher than median tubercle in dorsal view, and each bearing 2 or 3 setae apically; median tubercle situated on ventral side of head, with 2 (?) or 4 setae (2 anterior ones are often difficult to detect). Eye of normal shape, with about 2/3 of its facets visible from above, with a prominent triommatidion. Antenna 5-segmented, a little shorter than half body length; 1st segment scabrous, angulate at inner side; 2nd scabrous, with 2 minute setae; 3rd jagged along inner side, smooth on outer side except at apex; 4th and 5th imbricated; processus terminalis 1.25–1.50 times as long as basal part of 5th; 3rd–5th in proportion of 100:38:38+52 in length. Clypeus sparsely spinulous, depressed anteriorly, with 4 setae anteriorly; mandibular lamina spinulous, with 1 or 2 setae. Rostrum reaching between fore and middle coxae; ultimate segment obtuse, parallel-sided, 1.10–1.41 times as long as wide, 1.10–1.30 times as long as 2nd segment of hind tarsus, with a pair of secondary setae. Femora spinulous ventrally in fore and middle legs, spinulously imbricated on apical 1/2–2/3 in hind leg. Tibiae imbricated at apex; dorsal setae very short; ventroapical setae as long as or a little longer than middle width of hind tibia. Tarsi with 2nd segment wanting secondary setae; first tarsal chaetotaxy 3:3:2. Thoracic tergites deeply pigmented. Mesosternal furca sessile, with arms connected by a chitinous band. Abdomen with first 7 tergites consolidated; anterior tergites deeply pigmented, with mosaic wrinkles; 7th and 8th tergites paler than foregoing ones, imbricated with minute denticles, with weak papillae mingled among imbrications; marginal tubercles usually absent (in one specimen some rudimental ones are seen). Abdominal sternites nearly smooth spinopleurally, with dark intersegmental areolations forming narrow bands which are joined marginally to the spiracular sclerites; ventral setae mostly minute. Dorsal setae on abdomen minute and

Table 2. Biometric data for *Vesiculaphis rotunda*: apterous viviparous female (N=20). Range and mean (in parentheses) are given in mm.

Body: L	1.20–1.40 (1.32)	Siphunculus: L	0.28 –0.30 (0.29)
W	0.74–0.92 (0.81)	W at middle	0.049–0.058 (0.054)
Head: L	0.17–0.22 (0.19)	Cauda: L	0.080–0.093 (0.082)
W across eyes	0.36–0.42 (0.39)	W	0.053–0.065 (0.061)
Cephalic shield: W	0.28–0.32 (0.29)	Ult. rost. seg.	0.053–0.068 (0.061)
Antenna: L (whole)	0.55–0.61 (0.59)	Hind tarsal II	0.043–0.053 (0.048)
Seg. III	0.19–0.23 (0.21)	Setal length maxima on:	
Seg. IV	0.07–0.09 (0.08)	median tubercle (head)	0.008–0.013 (0.010)
Base V	0.08–0.09 (0.08)	latero-frontal projection (head)	minute and mostly unmeasurable (*ca.* 0.005)
Proc. term.	0.10–0.12 (0.11)	cephalic disc	
Hind femur	0.26–0.29 (0.28)	abdominal disc	
Hind tibia	0.43–0.46 (0.45)	abdominal VIII	

Abbreviations as in Table 1.

blunt; their arrangement is as follows:–first 4 tergites each with 6–10 setae besides marginal ones, which are mostly 2 in number on each side; 5th with a pair of mesial and a pair of pleural setae (the latter pair effaced in some specimens), without marginal setae; 6th with a pair of mesial setae between siphunculi; 7th with 2 setae posteromarginally; 8th semicircular, with 4 setae. Siphunculus cylindrical, bent inward at base, abruptly attenuated at apex, 4.66–5.50 times as long as wide at middle, shorter than head width across eyes; the width at middle 2.29–2.87 times the narrowest part below flange; dorsal surface corrugated; ventral surface strongly spinulous inward, bearing spinulous or denticulate scales on middle area, the scales becoming smooth-edged near outer margin; flange small but distinct. Cauda round at apex, attenuated at apical 1/3, constricted at base, 1.23–1.48 times as long as wide, 1/3 as long as siphunculus, with 4 setae, with spinules arranged to form areolation apically. Abdominal sternites smooth, with minute setae. Genital plate oval, with a pair of setae anteriorly, and 7–9 setae along hind margin.

Specimens examined: 20 apterous viviparous females (syntypes), Komagane-kôgen, Komagane, Nagano Pref., 1–xi–1970, ex *Carex siderosticta* (coll. no. 2797).

Host plants: *Carex siderosticta*. The specimens were found solitarily on the undersurface of the leaves.

Taxonomic notes: This species is readily recognized by the thoracic and abdominal terga deeply pigmented. It is allied to *V. caerulea* in that the frontal ledge of the head is markedly produced laterally. It is distinguished from the latter by the colouration of the body, the eyes of normal shape, the siphunculus of a different shape, and by the antenna with a shorter processus terminalis.

4. *Vesiculaphis kongoensis* Takahashi

Vesiculaphis kongoensis Takahashi, Ins. matsum. 28(1): 47, 1965.

Specimens examined: Some alate viviparous females associated with alatoid nymphs (syntypes), Mt. Kongô, Ôsaka Pref., 30–vi–1961, ex *Rhododendron reticulatum*, R. Takahashi leg.

Host plants: This species was described on the basis of alatae collected from *Rhododendron reticulatum*. The alata on this plant is thought to migrate to the unknown secondary host plant.

Taxonomic notes: In the alatoid nymph the head is spinulous dorsally behind the compound eyes, and the laterofrontal prominences bear minute setae and do not protrude into pronounced projections. These characters of the alatoid nymph as well as the ones of the alata given in the key clearly show that this species belongs to the *caricis*-group.

V. kongoensis is known by the alate viviparous female, while the new species given above are described on the basis of the apterous viviparous females. Direct comparisons of the corresponding morphs are, therefore, not made between them. However, some differences found in immature stages may be sufficient to show that neither of the supposed new species represents the apterous form of *V. kongoensis*:– The alatoid nymph of *V. caerulea* is characterized by the laterofrontal prominences of the head well developed, as high as or a little lower than the 1st antennal segment (much lower than the segment in *V. kongoensis*) and much higher than the median tubercle (almost as high as the median tubercle), and by the compound eye with a peculiar swelling as in the apterous adult (without such a swelling). The larva of the apterous viviparous female of *V. rotunda* has the laterofrontal

prominences of the head as in *caerulea*, and also has the siphunculi constricted just below the flange more abruptly and more strongly than in *V. kongoensis*.

Geographical distribution: Japan (Honshû).

Theobaldi-group

5. *Vesiculaphis theobaldi* Takahashi

Trilobaphis caricis Theobald, Ent. mon. Mag. 58: 138, 1922.

Trilobaphis caricis: Theobald, Aphid. Great Brit. 1: 259, 1925; Hille Ris Lambers, Zool. Meded. 22: 95, 1939; Heinze, Beitr. Ent. 11(1, 2): 41, 1961.

Vesiculaphis theobaldi Takahashi (nom. nov. pro *T. caricis* Theobald), Proc. ent. Soc. Washington 32(1): 12, 1930.

Vesiculaphis theobaldi: Eastop, Ent. mon. Mag. 92: 274, 1956; Wood-Baker, Ent. mon. Mag. 93: 82, 1957, and 94: 101, 1958.

Specimens examined: Apterous and alate viviparous females, Soisy, S. Seine, France, 18–vi–1967, ex *Carex* sp., G. Remaudière leg.; Warszawa, Poland, 2–vi–1962, ex *Carex* sp., H. Szelegiewicz leg.; Horaždovice, Czechoslovakia, ex *Carex* sp., 4–ix–1960, D. Hille Ris Lambers leg.; Bennekom, Holland, vi–1977, ex *Carex remota*, Hille Ris Lambers leg.

Host plants: This species has been recorded from various species of *Carex*, usually infesting on the upperside of the leaves (Hille Ris Lambers, 1939; Börner, 1952; Heinze, 1961). It does not seem that the host alternation occurs in this species. Hille Ris Lambers (1939) mentions that "this species lives during the whole year on its various hosts (*Carex* spp.)," and Wood-Baker (1958) described the oviparous female from *Carex*. The emergence of the ovipara on *Carex* suggests the presence of a form which is monoecious and holocyclic on this plant. Of the specimens examined, on the other hand, those from Bennekom, Holland, belong to the form which appears to be anholocyclic on *Carex* (Hille Ris Lambers, in litt.).

Geographical distribution: Europe (known from England, Holland, France, Germany, Poland and Czechoslovakia). Ivanovskaja (1977) recorded "*Trilobaphis caricis*" from West Siberia (Altai Mts. and Novosibirsk). Judging from the diagnosis of the species given by her, however, it differs from *V. theobaldi* in some respects: e.g. the first tarsal chaetotaxy is in the formula of 5:5:5 (3:3:2 in the genuine *theobaldi*), the ultimate rostral segment is with 4 secondary setae (2 setae), the abdomen of the alata bears well-developed sclerotic patches (usually wanting sclerites spinopleurally on the anterior abdominal segments), etc.

6. *Vesiculaphis nubilimaculata*, sp. n. (Plate III, Fig. 5A; Plate VII, Fig. 9; Table 3)

Apterous viviparous female. Body dark brown in life; antennae, legs, siphunculi and cauda concolorous with body. In mounted specimens body brown, about 1.5 mm. in length and 0.8 mm. in width.

Head with 3 frontal projections; laterofrontal projections about 2/3 as high as 1st antennal segment, each with 2 setae, which are stout, pointed and 1.3–1.4 times as long as the middle width of the 3rd antennal segment; median tubercle roundly rectangular, much lower than laterofrontal projections, only reaching basal half of the latter, with 2 pairs of setae, which are similar to those on laterofrontal projections; dorsal shield lightly pigmented, markedly pustulate, protruded laterally into a triangular or rectangular prominence before eyes, with 2 pairs of

minute and blunt setae posteriorly; ventral surface of head with many spinules arranged in irregular rows, on each side with 3–5 (mostly 3) setae, which are drawn out at apices and 30–35 μ long; antennal tubercles each with a ventral seta. Antenna 5-segmented, but the 3rd segment often showing a trace of division into 2 sections, 0.43–0.49 as long as body; 1st segment roundly gibbous and scabrous apicomesially; 3rd segment about as long as 4th and 5th put together, serrated mesially, imbricated dorsally, the imbrication being distinct at apex but becoming obsolete basally; 4th and 5th segments conspicuously imbricated; processus terminalis 1.19–1.40 times as long as basal part of 5th; 3rd–5th in proportion of 100: 34: 28+38 in length. Clypeus with 4 setae and some spinules anteriorly; mandibular laminae sparsely spinulous, each with 2 setae. Rostrum at most just attaining bases of middle coxae; ultimate segment nearly parallel-sided, as long as 2nd segment of hind tarsus, with a pair of secondary setae. Femora imbricated apically, otherwise smooth; tibiae smooth in fore and middle legs, with fine denticles on apical portion in hind legs, with setae at most as long as middle width of the tibia in each leg; second tarsal segment with some 3 secondary setae and with scales often adorned with conspicuous spinules; first tarsal chaetotaxy 3:3:2. Mesosternal furca with arms completely separated from each other. Thoracic and abdominal tergites pigmented and pustulate as on cephalic shield. Abdomen with intersegmental areolations on dorsum ill defined and slightly darker than other parts of tergites; ventral intersegmental areolations also with ill-defined facets, conspicuously pigmented, the pigmentation being fused to dark sclerotized area surrounding spiracles; abdominal sternites with a linear or scaly pattern of spinules which are very weakly developed spinopleurally, often quite smooth marginally except on the 2nd segment where the spinulous pattern is well developed; dorsal setae on anterior segments minute and blunt; 8th tergite semicircular, with 2 pairs of setae, of which the mesial setae are longer, about 30 μ in length. Genital plate with a pair of setae anteriorly and 2–4 setae posteriorly. Siphunculus slightly shorter than head width across eyes, 5.8–6.6 times as long as wide at middle, much similar in shape to that of *angusticeps*, but with scales on midventral surface much larger and denticulate on edge. Cauda 0.33–0.35 as long as siphunculus, with 4 or 5 setae, and with apical areolation incomplete.

Table 3. Biometric data for *Vesiculaphis nubilimaculata*: apterous viviparous female (N=8). Range and mean (in parentheses) are given in mm.

Body: L	1.36–1.60 (1.48)	Siphunculus: L	0.38 –0.42 (0.40)
W	0.71–0.84 (0.80)	W at middle	0.058–0.073 (0.064)
Head: L	0.19–0.22 (0.21)	Cauda: L	0.110–0.120 (0.117)
W across eyes	0.39–0.44 (0.43)	W	0.068–0.078 (0.074)
Cephalic shield: W	0.29–0.33 (0.31)	Ult. rost. seg.	0.070–0.078 (0.074)
Antenna: L (whole)	0.63–0.71 (0.66)	Hind tarsal II	0.055–0.068 (0.061)
Seg. III	0.26–0.31 (0.27)	Setal length maxima on:	
Seg. IV	0.09–0.10 (0.09)	median tubercle (head)	0.033–0.035 (0.033)
Base V	0.07–0.08 (0.08)	latero-frontal projection (head)	0.028–0.035 (0.032)
Proc. term.	0.10–0.11 (0.10)	cephalic disc, abdominal shield	minute and mostly unmeasurable (*ca.* 0.005)
Hind femur	0.32–0.37 (0.35)		
Hind tibia	0.52–0.61 (0.57)		
		abdominal VIII	0.025–0.033 (0.027)

Abbreviations as in Table 1.

Specimens examined: 8 apterous viviparous females (syntypes), Mt. Taisetsu (near Yukomambetsu), Hokkaidô, 15–viii–1970, ex *Carex* sp. (coll. no. 2705).

Host plants: *Carex* sp. A small number of specimens were found infesting the undersurface of the leaves.

Taxonomic notes: This species is allied to *V. theobaldi* but distinguished by the following characters: – 1) head with median tubercle distinctly lower than laterofrontal projections (as high as or a little lower in *V. theobaldi*), 2) intersegmental areolations on abdomen with ill-defined facets (with clearly defined facets), 3) utlimate rostral segment nearly parallel-sided (distinctly tapering), 4) abdominal sternites smooth marginally (conspicuously scabrous with rows of spinules), 5) siphunculi with larger and denticulate scales.

The present species is distinguished from *V. cephalata* as follows: – head with rows of spinules ventrally (smooth or at most with some blunt nodules in *V. cephalata*); first antennal segment roundly gibbous at inner apex (conically protruded); median tubercle of head, intersegmental areolations and sternites of abdomen, and siphunculi as mentioned above.

7. *Vesiculaphis cephalata* Miyazaki (Fig. 1D; Plate I, Fig. 3B; Table 4)

Vesiculaphis cephalata Miyazaki, Ins. matsum. 34(1): 98, 1971.

This species has been known only by the apterous viviparous female. On this occasion a description of the alate viviparous female is given.

Alate viviparous female. Body in life yellow with head, thorax and sclerites on abdomen black. Antennae and siphunculi dark. Cauda dusky. Legs yellowish brown; femora at apex, tibiae apically and tarsi black. Body about 1.9 mm. in length in mounted specimens.

Head smooth dorsally and ventrally; median tubercle conspicuous, bearing 4 setae, which are thick, pointed and 0.83–1.20 times as long as the middle width of the 3rd antennal segment; laterofrontal projections weakly developed, much lower than median tubercle, each with 2 setae which are similar to those on the median tubercle; posterior discal setae pointed or blunt at tip, 0.35–0.50 as long as middle width of 3rd antennal segment. Antenna 0.63–0.71 as long as body; flagellum imbricated, with transversely oval rhinaria more or less elevated and numbering 26–35 (30 in mean) on 3rd segment, 5–14 (10) on 4th and 0–7 (2) on 5th; flagellar setae pointed, 0.43–0.60 as long as middle width of 3rd segment; 1st antennal segment produced at inner apex, but not so strongly as in apterous viviparous female, so that the articulation to the 2nd segment is not oblique, hardly or very weakly angulated at middle part of inner margin; 3rd segment as long as or a little longer than 4th and 5th together; processus terminalis 1.25–1.50 times as long as basal part of 6th; 3rd–6th segments 100:50:40:34+47 in relative length. Ultimate rostral segment blunt, slightly tapering, 1.40–1.74 times as long as wide at base, 0.73–0.92 as long as 2nd segment of hind tarsus, bearing 0–2 secondary setae. Fore wing with media twice branched. Femora smooth, at most with sparse spinules near apex; first tarsal chaetotaxy usually 3:3:2, but 3:3:3 in some specimens. Abdomen with marginal sclerites of 2nd–4th segments developed, round and spinulated; antesiphuncular sclerites absent; postsiphuncular sclerites developed; 2nd–7th segments each with a broad sclerotic band; the dorsal bands are smooth on 2nd–6th segments, imbricated with rows of denticles on 7th, mostly broken spinally, and often much reduced in size on 2nd and 6th; 8th tergite semicircular, roundly pointed posterospinally, wholly sclerotized and pigmented,

with denticulate imbrications, and with 4 or 5 pointed setae about as long as middle width of 3rd antennal segment; dorsal setae of anterior segments pointed, 0.42–0.64 as long as middle width of 3rd antennal segment. Siphunculus gently swollen near middle, 7.14–8.55 times as long as thick at the swollen portion, as long as or slightly shorter than 3rd antennal segment, imbricated with denticulate scales, the dorsal scales being larger than but not so strongly edged as ventral ones. Cauda attenuated on apical half, about 1.56–1.93 times as long as wide at base, 0.31–0.41 as long as siphunculus, with 2 pairs of setae. Genital plate oval, with a pair of setae anteriorly, 4–8 setae along hind margin, and with 0–7 additional setae on middle area.

Table 4. Biometric data for *Vesiculaphis cephalata*: alate viviparous female (N= 12). Range and mean (in parentheses) are given in mm.

Body: L	1.75–2.10 (1.93)	Siphunculus: L	0.35 –0.41 (0.37)
Head: L	0.22–0.25 (0.24)	W at middle	0.045–0.053 (0.047)
W across eyes	0.43–0.45 (0.44)	Cauda: L	0.120–0.148 (0.133)
Antenna: L (whole)	1.17–1.38 (1.29)	W	0.075–0.090 (0.083)
Seg. III	0.36–0.42 (0.39)	Ult. rost. seg.	0.070–0.090 (0.080)
Seg. IV	0.19–0.25 (0.22)	Hind tarsal II	0.080–0.110 (0.096)
Seg. V	0.15–0.21 (0.19)	Setal length maxima on:	
Base VI	0.13–0.16 (0.14)	median tubercle (head)	0.024–0.030 (0.028)
Proc. term.	0.17–0.21 (0.19)	latero-frontal projection (head)	0.024–0.033 (0.028)
Hind femur	0.46–0.53 (0.50)	cephalic disc	0.009–0.015 (0.012)
Hind tibia	0.82–0.97 (0.91)	abdominal disc	0.011–0.019 (0.014)
		abdominal VIII	0.026–0.031 (0.029)

Abbreviations as in Table 1.

Specimens examined: Alate viviparous females, Sapporo, Hokkaidô, 15–ix–1968; Tadami, Fukushima Pref., 30–ix–1977; Mt. Hodaka, Nagano Pref., 6–ix–1970; Mt. Kiso-komagatake, Nagano Pref., 29–viii–1970. Apterous viviparous females, Sapporo, Hokkaidô, 27–vi, 21–vii and 4–viii–68 (syntypes), and 15–ix–1968; Mt. Taisetsu, Hokkaidô, 15–viii–1970; Tadami, Fukushima Pref., 30–ix–1977; Mt. Nasu, Tochigi Pref., 28–vii–1976; Nikkô, Tochigi Pref., 10–vii–1977, Mt. Hodaka, Nagano Pref., 6–ix–1970; Mt. Kiso-komagatake, Nagano Pref., 29–viii–1970.

Host plants: All the specimens were collected from *Carex* spp. They usually feed on the undersurface of the leaves.

Geographical distribution: Japan (Hokkaidô and Honshû).

8. *Vesiculaphis angusticeps*, sp. n. (Plate III, Fig. 5B; Plate VIII, Fig. 10; Table 5)

Apterous viviparous female. Body elongately oval, pale yellow to dull yellowish brown, sometimes with a green tint. Antennae, legs, siphunculi and cauda pale. Eyes black. Body about 2.0 mm. in length and about 0.9 mm. in maximum width in mounted specimens.

Head obscurely warty dorsally, wrinkled or denticulated laterally and posteriorly, spinulated ventrally; front with 3 conspicuous projections about as high as 1st antennal segment; the median one rectangular, with 4 setae, and the lateral ones thumb-shaped, with 2 setae; the setae stout, up to 45 μ in length; dorsal shield protruded laterally just before eye into a triangular or trapezoid prominence,

0.82–0.99 as long (including median tubercle) as wide at the lateral prominences, narrower than head width, with 2 pairs of minute and blunt setae posteriorly, which are about 5–8 μ long; ventral setae thin, with drawn-out apices, up to 35–45 μ long. Antenna 5-segmented, 0.33–0.43 as long as body; 1st segment roundly produced at inner apex, so that the joint to 2nd segment is oblique; 2nd segment imbricated, with 3 or 4 setae; 3rd segment nearly smooth, serrated at inner surface, sometimes weakly imbricated apically, with sparse setae at most 0.3–0.5 as long as middle width of the segment; processus terminalis 1.05–1.34 times as long as basal part of 5th segment; 3rd–5th as 100:38:35+41 in relative length. Clypeus with a few spinules and 4 setae anteriorly; mandibular lamina sparsely spinulous, with 1–4 setae. Rostrum just reaching middle coxae; ultimate segment tapering, 1.71–2.26 times as long as wide, 1.24–1.42 times as long as 2nd segment of hind tarsus, with a pair of secondary setae. Femora spinulous ventrally in fore legs and sometimes also in middle legs, usually smooth in hind legs. Tibiae smooth in fore and middle legs, usually with some spinules apically in hind legs. First tarsal chaetotaxy 3:3:2, or 3:3:3 in some specimens; 2nd segment with 2 dorsal and 0–2 ventral secondary setae in all legs. Pronotum weakly warty, with areolations variable in size and number. Mesonotum spinopleurally with a pair of large elliptical sclerotized areas weakly warty and enclosing areolations, and marginally with a sclerotized denticulate area; mesosternal furca sessile, with arms connected by a chitinous band. Metanotum sclerotic with marginal area thicker and denticulate. Abdomen with first 6 segments pale, wrinkled, bearing dark intersegmental areolations; 7th and 8th tergites pigmented, imbricated with spinules and fine denticles; dorsal setae very short, blunt at tip, their arrangement as follows: first 4 tergites each with 6–8 setae besides marginal ones, which are usually 2 in number on each side; 5th with 4 or 5 setae spinopleurally, and with a marginal seta on each side; 6th with a pair of setae mesially; 7th with a pair of setae posteromarginally; 8th with 4 setae. Ventral setae of abdomen pointed at tip, variable in length, the longer ones being 15–23 μ. Siphunculus weakly S-shaped on inner margin, 6.00–8.28 times as long as wide at middle, a little longer than head width across eyes; the width at middle 2.08–2.95 times the narrowest width below flange; dorsal surface nearly smooth except bearing at apex flat and rather obscure

Table 5. Biometric data for *Vesiculaphis angusticeps*: apterous viviparous female (N=35). Range and mean (in parentheses) are given in mm.

Body: L	1.70–2.21 (2.03)	Siphunculus: L	0.44 –0.58 (0.48)
W	0.70–1.02 (0.92)	W at middle	0.055–0.080 (0.070)
Head: L	0.30–0.37 (0.33)	Cauda: L	0.145–0.175 (0.155)
W across eyes	0.43–0.50 (0.45)	W	0.075–0.098 (0.085)
Cephalic shield: W	0.30–0.40 (0.36)	Ult. rost. seg.	0.095–0.113 (0.104)
Antenna: L (whole)	0.68–0.83 (0.74)	Hind tarsal II	0.070–0.085 (0.077)
Seg. III	0.23–0.32 (0.27)	Setal length maxima on:	
Seg. IV	0.09–0.13 (0.10)	median tubercle (head)	0.030–0.045 (0.035)
Base V	0.09–0.11 (0.10)	latero-frontal projection (head)	0.028–0.035 (0.031)
Proc. term.	0.10–0.13 (0.11)		
Hind femur	0.35–0.48 (0.40)	cephalic disc, abdominal disc	minute and mostly unmeasurable (*ca.* 0.007)
Hind tibia	0.60–0.70 (0.65)		
		abdominal VIII	0.008–0.013 (0.010)

Abbreviations as in Table 1.

imbrications; ventral surface strongly scabrous with rather small scales, which are larger and flatter on the outer surface than on the inner. Cauda markedly constricted at base and at apical third, 1.71–2.07 times as long as wide, bearing 4 setae, with apical areolation well developed. Genital plate with 5–11 irregularly scattered setae in addition to a pair of anterior ones.

Specimens examined: 20 apterous viviparous females (syntypes), Mt. Norikura (near Hirayu), Gifu Pref., 7–ix–1970 (coll. no. 2838) and 8–ix–1970 (coll. no. 2842, 2844 & 2867), ex *Carex* sp. Besides the syntypes many apterous viviparous females were examined: – Katsura-koba, Ina-shi, Nagano Pref. (28–viii–1970, coll. no. 2769); Tokusawa, Nagano Pref. (4–ix–1970, coll. no. 2814); Shin-hodaka, Gifu Pref. (9–ix–1970, coll. no. 2853).

Host plants: All the specimens examined were collected from the under-surface of the leaves of *Carex* spp.

Taxonomic notes: This species is readily distinguished from all the other congeners by the elongate head, of which the dorsal shield is narrower than the head width excluding eyes.

9. *Vesiculaphis samagaltaica* (Ivanovskaja-Shubina)

Pentaceratinaphis samagaltaica Ivanovskaja-Shubina, Acad. Sci. USSR, Siberian Branch, Inst. Biol. 1965: 59.

Pentaceratinaphis samagaltaica: Ivanovskaja, Aphids of West Siberia II: 166, 1977.

Vesiculaphis samagaltaica: Eastop and Hille Ris Lambers, Survey of the world's aphids p. 454, 1976.

Taxonomic notes: The cephalic projections depicted by Ivanovskaja (1965 & 1977) suggest that this species belongs to the *theobaldi*-group, and that it is especially related to *V. nubilimaculata* in that the median tubercle of the head is much lower than the laterofrontal projections. However, in *V. samagaltaica* the siphunculus is swollen at the middle, the abdomen shows a different type of intersegmental areolations (clearly defined facets are scattered segmentally in a transverse row), and the formula of the first tarsal chaetotaxy is 2:2:2.

Host plants: This species was described from a moss. Although in the original description no statement on the type material is given, Ivanovskaya's (1977) treatment suggests that this species was described on a single specimen. This may show that the supposed host relationship is dubious.

Geographical distribution: Russia (Tubinskaja).

Pieridis-group

10. *Vesiculaphis pieridis* Basu

Vesiculaphis pieridis Basu, J. Linn. Soc. (Zool.) 45: 237, 1964.

Vesiculaphis pieridis: Ghosh, Basu and Raychaudhuri, Orient. Ins. 10(2): 274 & 276, 1976.

Specimens examined: 4 apterous viviparous females, Darjeeling, India, 18–vii–1957, ex *Pieris ovalifolia*, A. N. Basu leg., no. 106 (paratype); Shillong, Assam, India, 11–ii–1969, ex *Pieris ovalifolia* (without collector's name). Two alate viviparous females, Lebong, Darjeeling, 19–iv–1971 (without collector's name).

Host plants: *Pieris ovalifolia*. This species is recorded on *P. ovalifolia* in India as viviparae in July, October and from December to April (Basu, 1964, Chakrabarti and Raychaudhuri, 1975; Ghosh, Basu and Raychaudhuri, 1976). This suggests

that it lives on *Pieris* throughout the year anholocyclically.

Geographical distribution: India.

11. *Vesiculaphis grandis* Basu

Vesiculaphis grandis Basu, J. Linn. Soc. (Zool.) 45: 235, 1964.

Specimens examined: 2 apterous and 1 alate viviparous females (paratypes of the species), Darjeeling, 21–v–1958, ex *Rhododendron* sp., S. Das leg. (no. 195).

Host plants: *Rhododendron* sp.

Taxonomic notes: It may be worth noting that this species bears many supernumerary setae, which is an unusual character in *Vesiculaphis*. The specimens examined are not clear enough to count all of the setae, but one of the apterae shows at least 17 setae on the dorsal surface of the head including the median and the antennal tubercles and 8 setae on the prothorax spinopleurally. The alata bears 29 setae on the head seen from above. The embryo also bears supernumerary setae. In this connection it should be pointed out here that the siphunculi bear some minute setae on the dorsal surface in both apterae and alatae.

Geographical distribution: India.

12. *Vesiculaphis rhododendri* Ghosh and Raychaudhuri

Vesiculaphis rhododendri Ghosh and Raychaudhuri, Orient. Ins. 6(3): 383, 1972.

Vesiculaphis rhododendri: Ghosh, Basu and Raychaudhuri, Orient. Ins. 10(2): 274 & 276, 1976.

Specimens examined: 1 apterous viviparous female (paratype), Wort Lake, Shillong, Meghalaya, India, 7–ii–1971, ex *Rhododendron* sp., S. Sakar leg. (no. PLA 3701).

Host plants: *Rhododendron* sp.

Taxonomic notes: The following characters observed in the specimen examined should be given: – the siphunculi are clavate and bear large, flat warts rather uniform in size; the abdominal tergum is not sclerotized on the anterior segments; the 6th abdominal segment is not reduced in size marginally.

Geographical distribution: India.

Notes on other species described under the genus Vesiculaphis

The following species were originally described as belonging to the genus *Vesiculaphis*. In the course of the present study, however, I have come to the conclusion that they are not true representatives of the genus.

Myzakkaia verbasci (Chowdhuri, Basu, Chakrabarti and Raychaudhuri)

Vesiculaphis verbasci Chowdhuri, Basu, Chakrabarti and Raychaudhuri, Orient. Ins. 3(1): 90, 1969.

Vesiculaphis verbasci: Ghosh, Orient. Ins. 7(3): 349, 1973; Ghosh, Basu and Raychaudhuri, Orient. Ins. 10(2): 274 & 276, 1976.

Myzakkaia verbasci: Eastop and Hille Ris Lambers, Survey of the world's aphids p. 288, 1976.

Myzakkaia himalayensis Basu, Orient. Ins. 3(2): 177, 1969.

Specimens examined: 4 apterous viviparous females (identified with *Vesiculaphis verbasci*), Dhankheti, Shillong, India, 9–viii–1969, ex *Polygonum alatum*, R. Basu leg., and Labor, Shillong, 28–vi–1969, ex *Polygonum alatum*, R. Basu leg.

Host plants: *Polygonum alatum* (Polygonaceae). Chowdhuri et al. (1969) give *Verbascum thapsus* (Scrophulariaceae) and *P. alatum* as host plants of this species.

Taxonomic notes: Ghosh (1973) suppressed *Myzakkaia himalayensis*, the type-species of *Myzakkaia*, as a synonym of *Vesiculaphis verbasci* and treated *Myzakkaia* as a synonym of *Vesiculaphis*. I have also come to the conclusion that *himalayensis* and *verbasci* belong to a single species. However, it is my opinion that this species should be referred to the distinct genus *Myzakkaia*, which differs from *Vesiculaphis* as follows: – Head of myzine type with well-developed antennal tubercles; prothorax with only a pair of setae mesially; 8th abdominal tergite band-like; and the siphunculi are of a different type.

Geographical distribution: India.

Myzakkaia kuwanais (Ghosh, Basu and Raychaudhuri), comb. n.

Vesiculaphis kuwanais Ghosh, Basu and Raychaudhuri, Orient. Ins. 4(1): 73, 1970.
Vesiculaphis kuwanais: Ghosh, Basu and Raychaudhuri, Orient. Ins. 10(2): 274 & 276, 1976.

Specimens examined: 2 apterous viviparous females, K. and J. Hills, Assam, India, 27–v–1967, without collector's name.

Host plants: Unknown.

Taxonomic notes: After Ghosh, Basu and Raychaudhuri (1970) this species is distinguishable from *M. verbasci* by the larger and plumpy body, the shorter antennae, the abdomen with a dorsal sclerotic pattern leaving marginal areas free, the thicker siphunculi, and by the first tarsal chaetotaxy which is formulated as 3:3:2. Other important characters of this species are as follows: – 7th abdominal segment not produced posteromesially (roundly produced in *M. verbasci*); abdominal spiracles with stigmal pori large and 12–18 μ in longer axis (7–15 μ, mostly less than 10 μ in *M. verbasci*); dorsal setae of head and abdomen long, about 18 μ on head, 23 μ on anterior abdominal segments, and 35 μ on 8th abdominal segment (about 6, 4 and 16 μ, respectively, in *M. verbasci*).

Judging from the original description, *Myzakkaia polygonicola* Basu resembles *M. kuwanais* in the long setae on the "frontal tubercles" and in the 7th and 8th abdominal tergites lacking "spinal tubercles". However, it is different from the latter in that the stigmal pori on the anterior abdominal segments are small and in that the first tarsal chaetotaxy is 3:3:3.

Geographical distribution: India.

Myzus kalimpongensis (Ghosh, Basu and Raychaudhuri), comb. n.

Vesiculaphis kalimpongensis Ghosh, Basu and Raychaudhuri, Orient. Ins. 10(2): 274, 1976.

Specimens examined: 5 apterous viviparous females (paratypes), Tashiding, Kalimpong, Darjeeling, India, 2–iv–1971, ex *Artemisia* sp., M. R. Ghosh leg., no. K2756.

Host plants: *Artemisia* sp. (Compositae). In the original description is also given *Leonurus sibiricus* (Labiatae) as a host.

Taxonomic notes: The head of this species bears well-developed antennal tubercles, which are gibbous and converging apically to each other, forming a conspicuous frontal sinus between them. The prothorax has only a single pair of

setae mesially. The 8th abdominal tergite is band-like, not produced posteromesially. The sinphunculus is straight and tapering. These characters, together with others, show that the species should be transferred to *Myzus*.

Geographical distribution: India.

Key to the species of Vesiculaphis

Apterous viviparous females

1. Head flattened dorsally like a shield, which is projecting anteriorly into a ledge or into laterofrontal projections and protruded laterally just before eyes into roundly triangular or rectangular prominences. Dorsal setae of head minute; the anterior and middle discals removed apicad to be located close to each other on laterofrontal portion (in *caricis*-group) or on laterofrontal projections (in *theobaldi*-group). First tarsal chaetotaxy usually 3:3:2. 2
- Head not flattened dorsally, protruded neither anteriorly nor laterally as stated above, with the frontal part concave like in *Cavariella*. Dorsal setae of head long or minute (in *grandis*); the anterior and middle discals located in usual position. First tarsal chaetotaxy 3:3:3. .....(*pieridis*-group).... 8
2. Head scabrous with many minute and acute denticles dorsally along posterior margin; frontal part produced into a ledge, with median tubercle as a low swelling hidden under the ledge. Body roundly oval. .....(*caricis*-group).... 3
- Head warty or with small, blunt nodules dorsally along posterior margin; frontal part with 3 conspicuously protruding lobes. Body elongately oval. .....(*theobaldi*-group).... 5
3. Head with frontal ledge gently wavy in a very shallow W-shape, not protruded laterally. Siphunculus stout, 60–95 μ wide at middle, abruptly and strongly constricted at apex, 3.87–4.54 times as long as wide at middle; the width at middle 3.43–5.33 times the width below flange; ventral surface spinulous on inner 1/2—2/3 without evidence of scales (outer portion imbricated). Body pale brown to brown, often mottled with green, or dark green in life, pale or pale brown in mounted specimens. .....*caricis* (Fullaway)
- Head with frontal ledge protruded and roundly angular laterally. Siphunculus not so stout, 45–60 μ wide at middle, at apex gently attenuated (in *caerulea*) or constricted more or less abruptly (in *rotunda*), more than 4.5 times as long as wide at middle; the width at middle 2.00–2.90 times the width below flange; ventral surface not so extensively spinulous as in *caricis*. Body differently coloured. 4
4. Thoracic and abdominal terga pale. Eye with a peculiar swelling ventromesially. Head with frontal ledge smooth ventrolaterally at least on its anterior half. Clypeus with 2 setae anteriorly. Siphunculus imbricated ventrally, with the inner margin serrated. Antenna with processus terminalis 1.50–2.15 times as long as basal part of 5th segment. Body in life pale green, with a bluish shade on head and thorax.....*caerulea*, sp. n.
- Thoracic and abdominal terga deeply pigmented. Eye normal, with no swelling ventromesially. Head with frontal ledge smooth ventrolaterally at most on its apical third. Clypeus with 4 setae anteriorly. Siphunculus with spinules not forming scales along inner margin and at apical portion, so that the inner margin is spiny. Antenna with processus terminalis 1.25–1.50 times as long as basal part of 5th segment. Body in life blackish brown dorsally with the ground color pale green. .....*rotunda*, sp. n.
5. Head with median tubercle low, at most half as high as laterofrontal projections. Abdomen with intersegmental areolations blurred with brown and not clearly outlined. Antenna with 1st segment roundly gibbous at inner apex. ....*nubilimaculata*, sp. n.

- Head with median tubercle as high as or higher than laterofrontal projections. Abdomen with intersegmental areolations clearly defined and either pale or pigmented. Antenna with 1st segment roundly gibbous (in *theobaldi*) or markedly protruded at inner apex. 6

6. Head narrow, 0.82–0.99 as long as width of cephalic shield at lateral prominences before eyes*; cephalic shield not overhanging laterally (before eye), being narrower across the lateral prominences than the head at that portion. Ultimate rostral segment 1.24–1.42 times as long as 2nd segment of hind tarsus. .... *angusticeps*, sp. n.
- Head broad, 0.53–0.85 as long as width of cephalic shield at lateral prominences before eyes; cephalic shield overhanging laterally, being slightly broader across the lateral prominences than head width at that portion. Ultimate rostral segment 0.81–1.21 times as long as 2nd segment of hind tarsus. 7

7. Head with rows of fine spinules ventrally. Ultimate rostral segment 1.09–1.21 times as long as 2nd segment of hind tarsus. Antenna with processus terminalis 1.37–1.79 times as long as basal part of the terminal segment..... ..... *theobaldi* Takahashi
- Head without fine spinules ventrally, at most with a few scattered blunt nodules. Ultimate rostral segment 0.81–1.03 times as long as 2nd segment of hind tarsus. Antenna with processus terminalis 1.05–1.34 times as long as basal part of the terminal segment. ..... *cephalata* Miyazaki

8. Head not sculptured. Abdomen with anterior tergites membranous and pale, and with intersegmental areolations conspicuous as dark spots; 6th tergite of normal size; 8th segment with 4 setae. Siphunculus clavate, with large and flat scales all of similar shape and size; the inner margin not serrated. Antenna 0.4 or more as long as body; processus terminalis as long as or longer than basal part of terminal segment. ..... *rhododendri* Ghosh and Raychaudhuri
- Head strongly sculptured. Abdomen with anterior tergites sclerotic and pigmented, with intersegmental areolations not sharply outlined; 6th tergite atrophied and hardly detectable behind siphunculi; 8th segment with about 10 setae. Siphunculus not clavate, with large papilla-like nodules and spiny denticles; the inner margin strongly serrated. Antenna less than 0.4 as long as body; processus terminalis shorter than basal part of terminal segment. 9

9. Head corrugated, with 4 pairs of setae dorsally. Abdomen with 7th segment wanting setae on spinopleural area; intersegmental areolations small (indistinct in summer specimens). Ultimate rostral segment 1.19–1.27 times as long as 2nd segment of hind tarsus, with 2 secondary setae. Tibiae smooth or with a small number of denticles apically in hind legs. Siphunculus 0.18–0.21 as long as body, without setae. Cauda with reticulation well developed at apical 1/5–1/4, and with 4–5 setae. Body 1.26–1.98 mm. in length. ..... *pieridis* Basu
- Head papillate, with some additional setae besides ordinary ones. Abdomen with 7th segment bearing some setae on spinopleural area; intersegmental areolations large and round, the marginal ones being about as large as compound eyes. Ultimate rostral segment about twice as long as 2nd segment of hind tarsus, with 6 secondary setae. Tibiae of all legs apically with many denticles, which extend till the base along the outer surface in the hind legs. Siphunculus about 0.25 as long as body, with some minute setae mingled among papilla-like scales. Cauda with incomplete reticulation at tip, with 8–13 setae. Body 3.39–4.65 mm. in length. ..... *grandis* Basu

V. samagaltaica (Ivanovskaja-Shubina) is excluded from the key as no specimen has been available. Judging from the original description, the species may be distinguished from any other species by the first tarsal chaetotaxy, which is represented in the formula

* The head length is measured from the apex of the median tubercle to the posterior end of the cephalic shield.

of 2:2:2. Further discussions are given in the text.

Alate viviparous females

1. Head with anterior and middle discals located close to each other on laterofrontal area. First tarsal chaetotaxy usually 3:3:2. 2
- Head with anterior and middle discals located in usual position. First tarsal chaetotaxy 3:3:3. .....(*pieridis*-group).... 5
2. Anterior and middle discals of head thin and much shorter than middle width of 3rd antennal segment. Cauda subpentagonal in shape, at most about 1.4 times as long as wide at base. Siphunculus at most about 0.18 as long as body, less than 0.75 as long as head width across eyes. .....(*caricis*-group).... 3
- Anterior and middle discals of head stout and subequal in length to middle width of 3rd antennal segment. Cauda of an elongate tongue-shape, at least about 1.5 times as long as basal width. Siphunculus at least about 0.18 as long as body, more than 0.75 as long as head width across eyes. .....(*theobaldi*-group).... 4
3. Fore wing with media once branched. Abdomen without sclerotic bands. Antenna 0.62–0.78 as long as body; 3rd segment smooth, with 28–54 rhinaria. Rostrum with ultimate segment 0.68–1.13 times as long as basal part of 6th antennal segment. .....*caricis* (Fullaway)
- Fore wing with media twice branched. Abdomen with narrow sclerotic bands on 3rd–5th tergites. Antenna 0.77–0.85 as long as body; 3rd segment imbricated, with 19–23 rhinaria. Rostrum with ultimate segment 0.47–0.50 as long as basal part of 6th antennal segment. .....*kongoensis* Takahashi
4. Abdomen usually without sclerotic bands on anterior segments. Antenna smooth on 3rd segment and often also on 4th; processus terminalis 1.76–2.40 times as long as basal part of 6th. .....*theobaldi* Takahashi
- Abdomen with broad sclerotic bands on 3rd–5th segments. Antenna imbricated on 3rd segment apically and on 4th wholly; processus terminalis 1.25–1.50 times as long as basal part of 6th. .....*cephalata* Miyazaki
5. Head with 4 pairs of setae dorsally. Antenna with 43–52 rhinaria on 3rd segment; processus terminalis 1.12–1.47 times as long as basal part of 6th segment. Rostrum with ultimate segment 1.16–1.30 times as long as 2nd segment of hind tarsus, bearing 2 secondary setae. Abdomen with intersegmental areolations inconspicuous; 7th tergite without setae on spinopleural area. Siphunculus without setae. Cauda with 4 setae. .....*pieridis* Basu
- Head with additional setae besides ordinary ones. Antenna with 82–85 rhinaria on 3rd segment; processus terminalis 0.83–0.84 as long as basal part of 6th segment. Rostrum with ultimate segment 1.88 times as long as 2nd segment of hind tarsus, bearing 6 secondary setae. Abdomen with intersegmental areolations well developed and pigmented; 7th tergite with some setae on spinopleural area. Siphunculus with some minute setae. Cauda with 7 setae. .....*grandis* Basu

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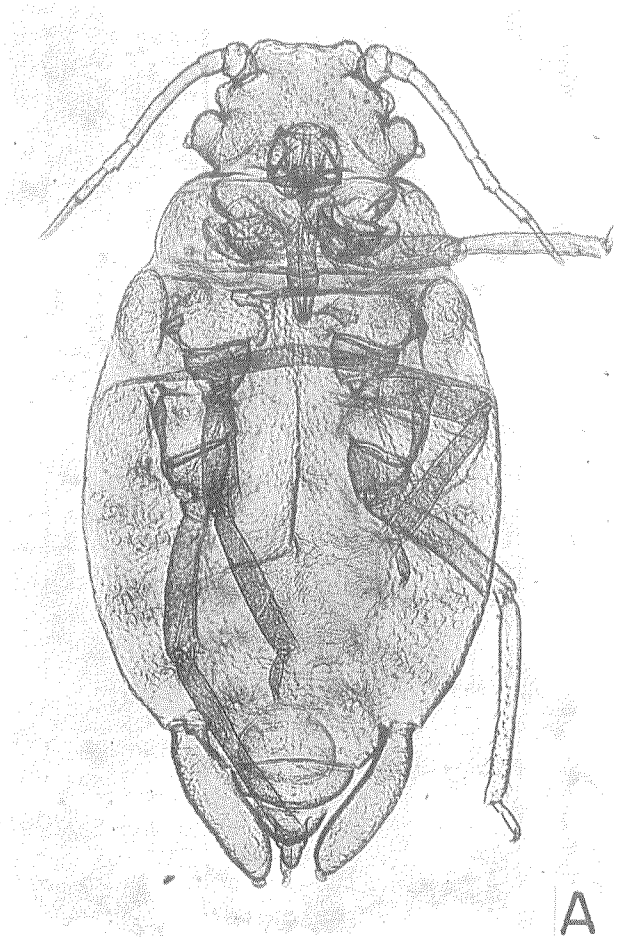
Other papers are given in the synonymies in the text.

PLATES

Plate I

Fig. 3. A: Apterous viviparous female (syntype specimen) of *Vesiculaphis caricis* (Fullaway).
B: Alate viviparous female of *Vesiculaphis cephalata* Miyazaki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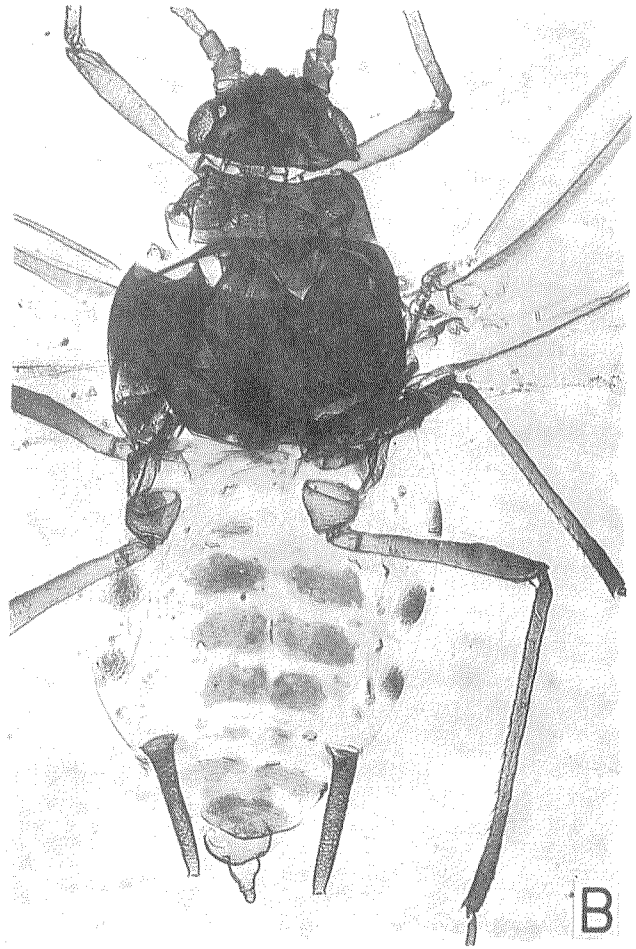
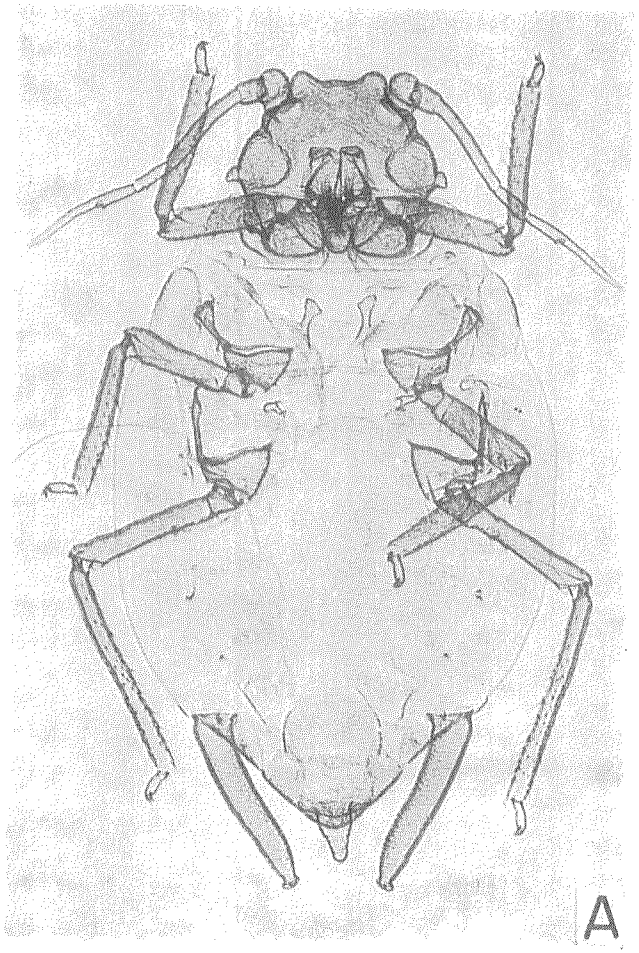

B

Plate II

Fig. 4. Apterous viviparous female of A: *Vesiculaphis caerulea*, sp. n. and B: *Vesiculaphis rotunda*, sp. n.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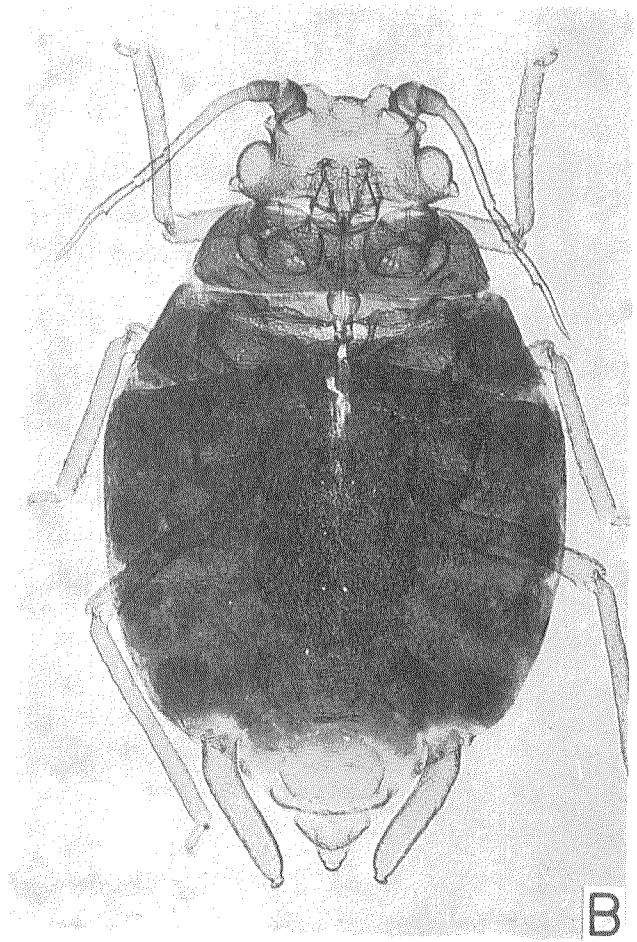
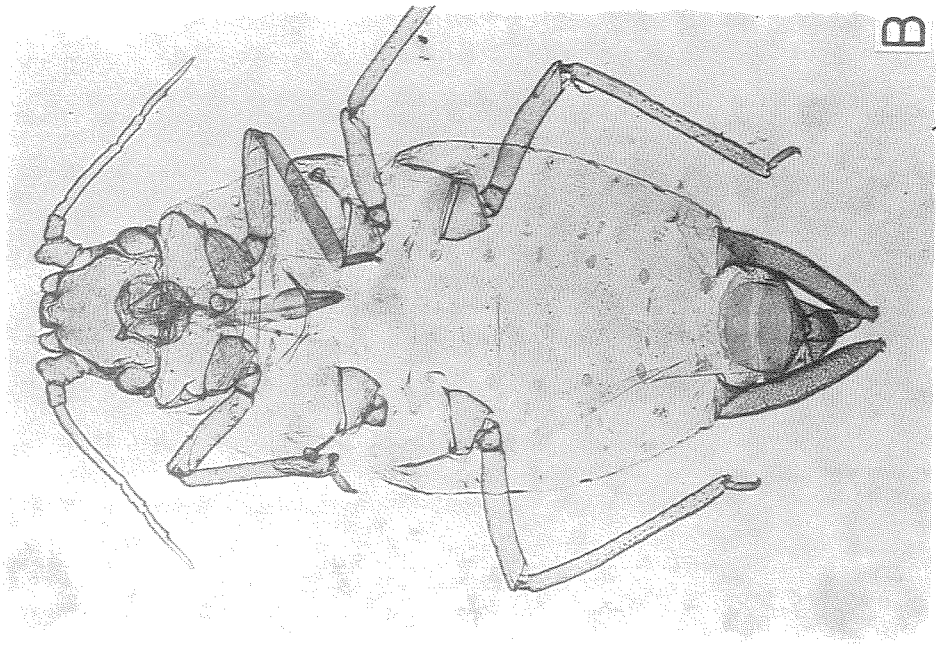

B

Plate III

Fig. 5. Apterous viviparous female of A: *Vesiculaphis nubilimaculata*, sp. n. and B: *Vesiculaphis angusticeps*, sp. n.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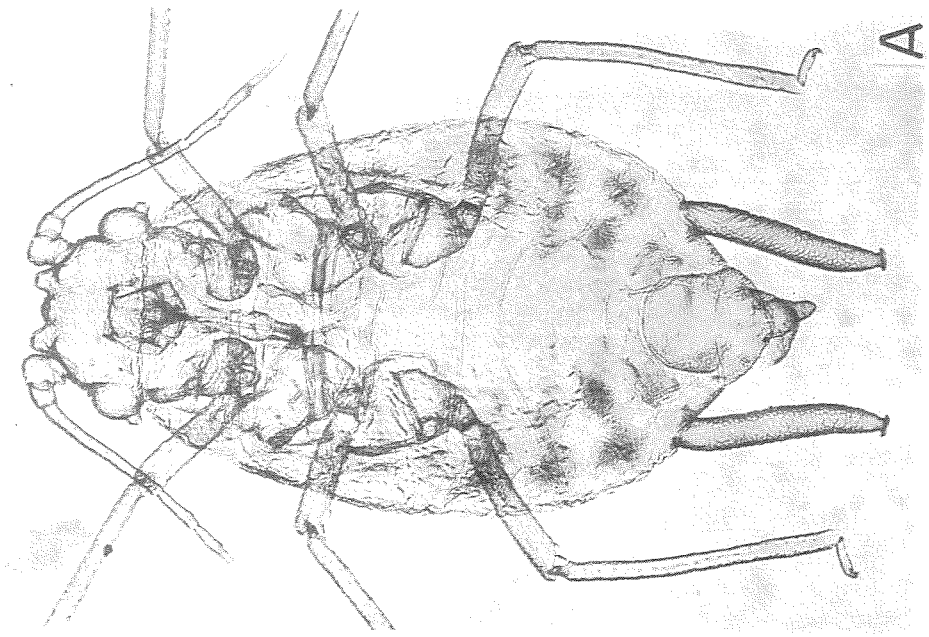
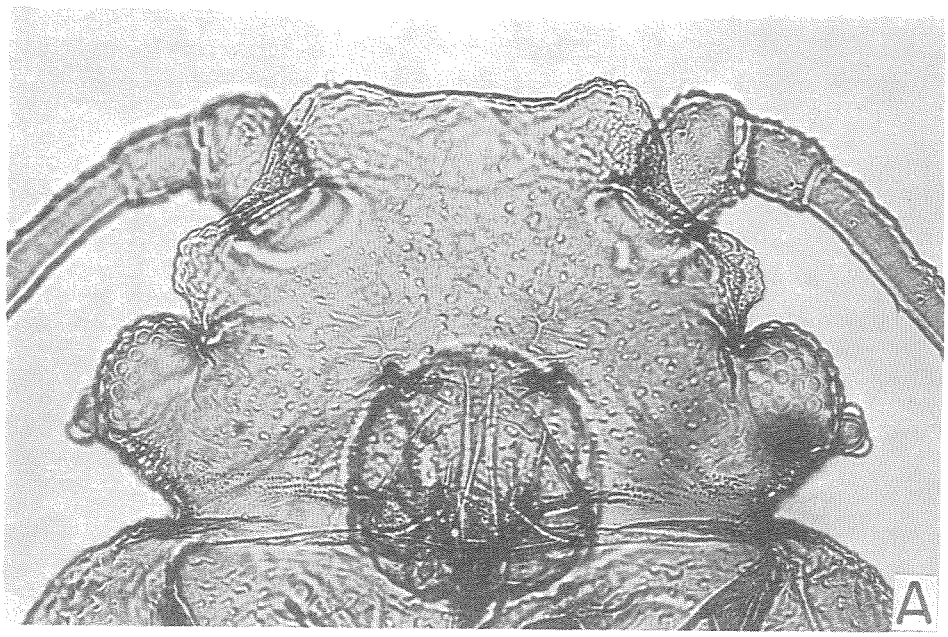

A

Plate IV

Fig. 6. *Vesiculaphis caricis* (Fullaway). Head (A) and caudal part (B) of the apterous viviparous female (syntype specimen).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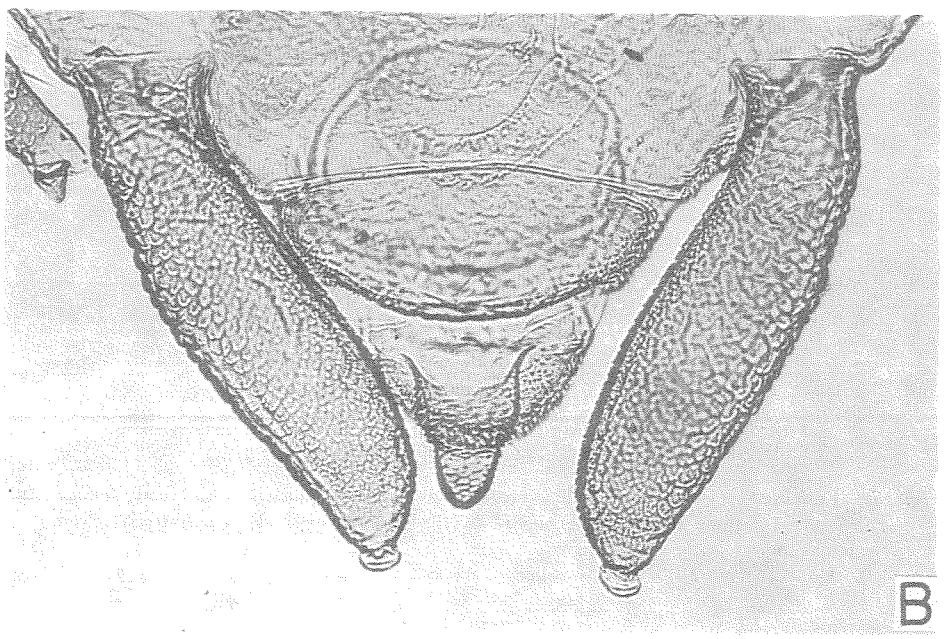
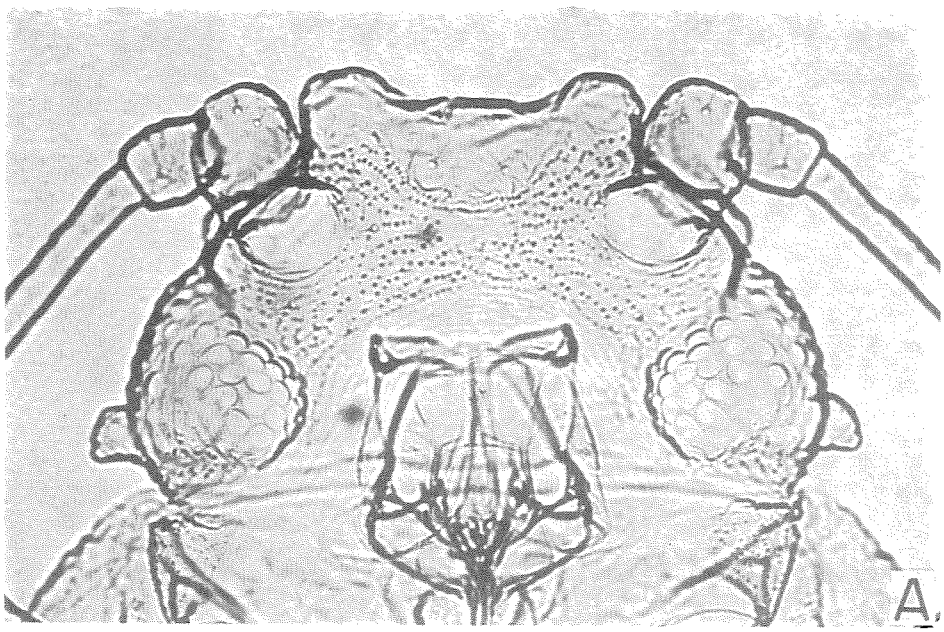

B

Plate V

Fig. 7. *Vesiculaphis caerulea*, sp. n. (apterous viviparous female). A: Head, focused on the ventral surface to show the mesial swelling of the eye. B: Caudal part.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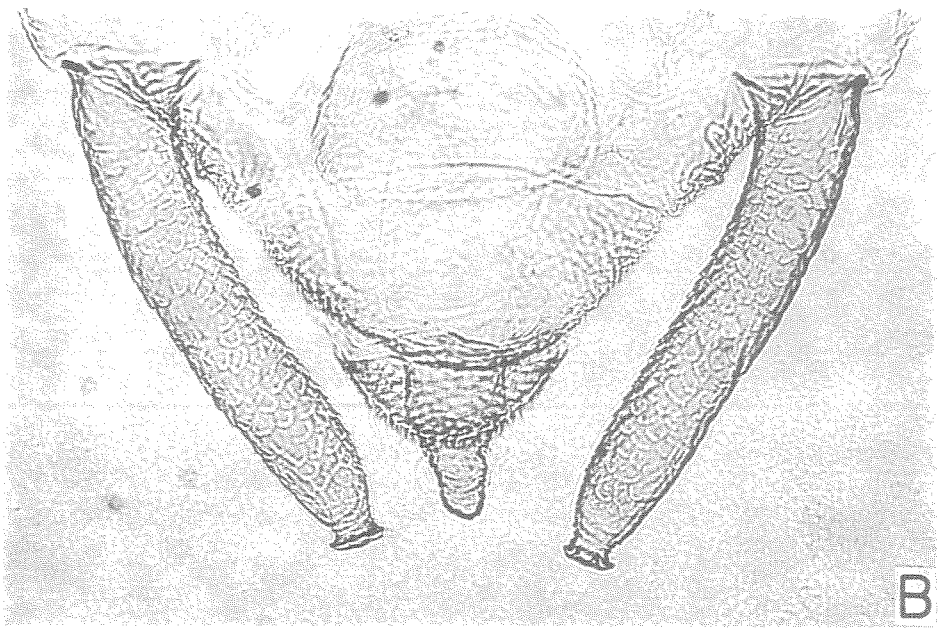
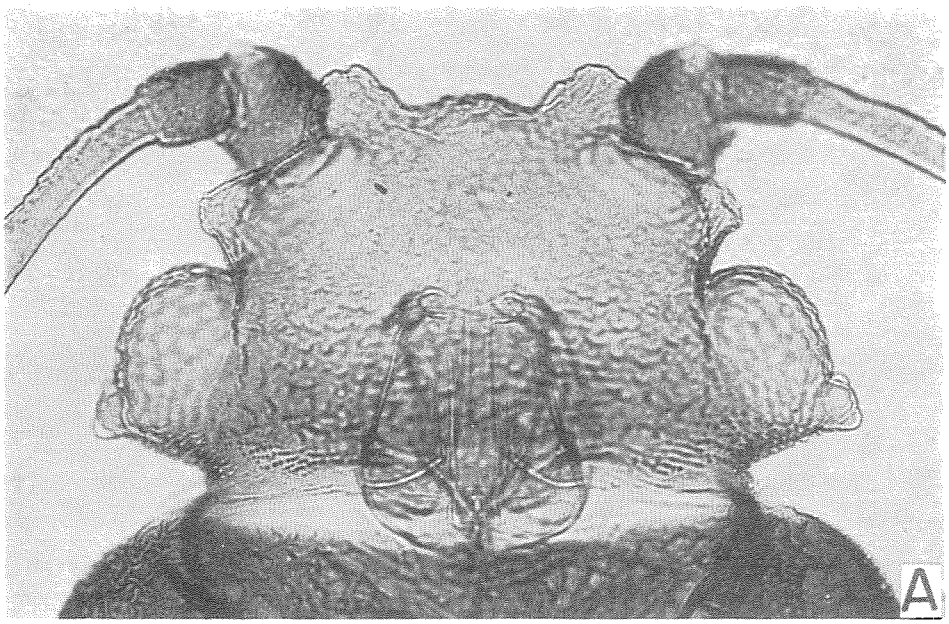

B

Plate VI

Fig. 8. *Vesiculaphis rotunda*, sp. n. Head (A) and caudal part (B) of the apterous viviparous female.


A

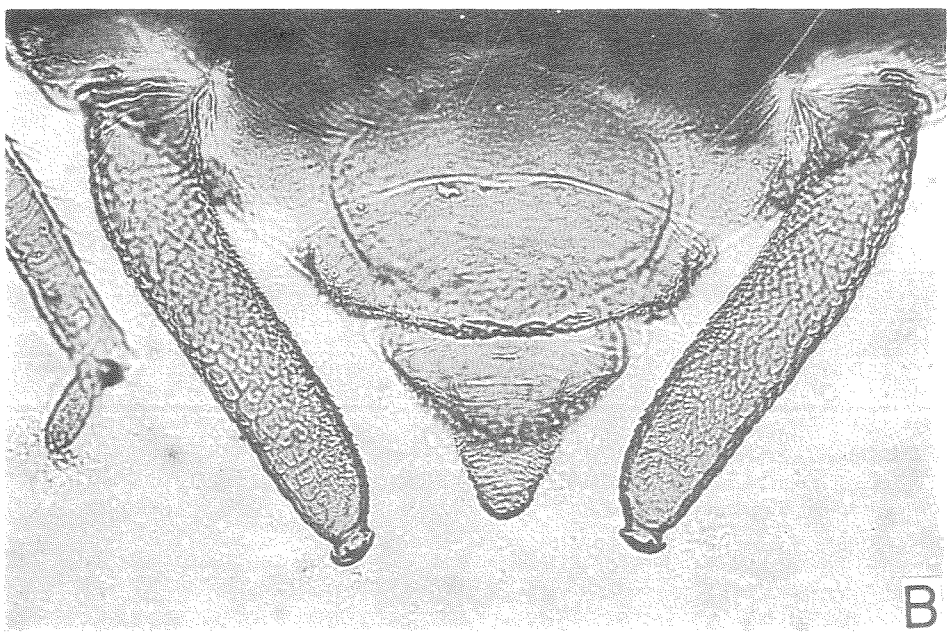
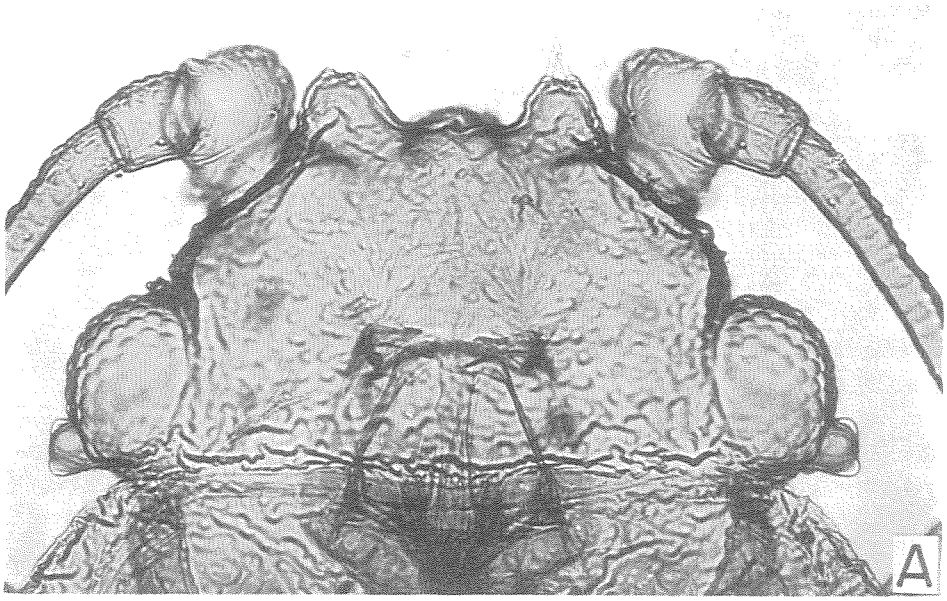

B

Plate VII

Fig. 9. *Vesiculaphis nubilimaculata,* sp. n. Head (A) and caudal part (B) of the apterous viviparous female.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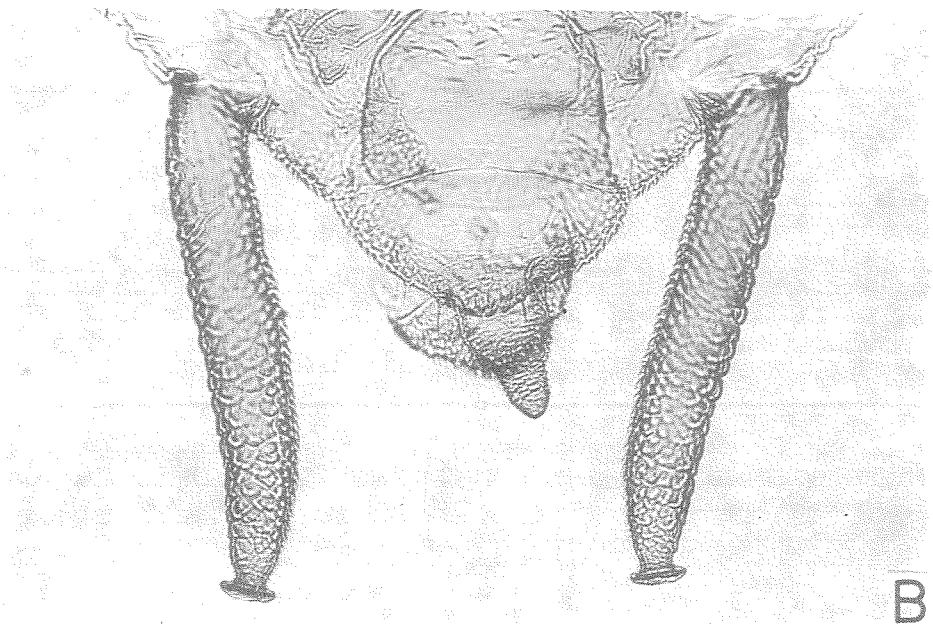
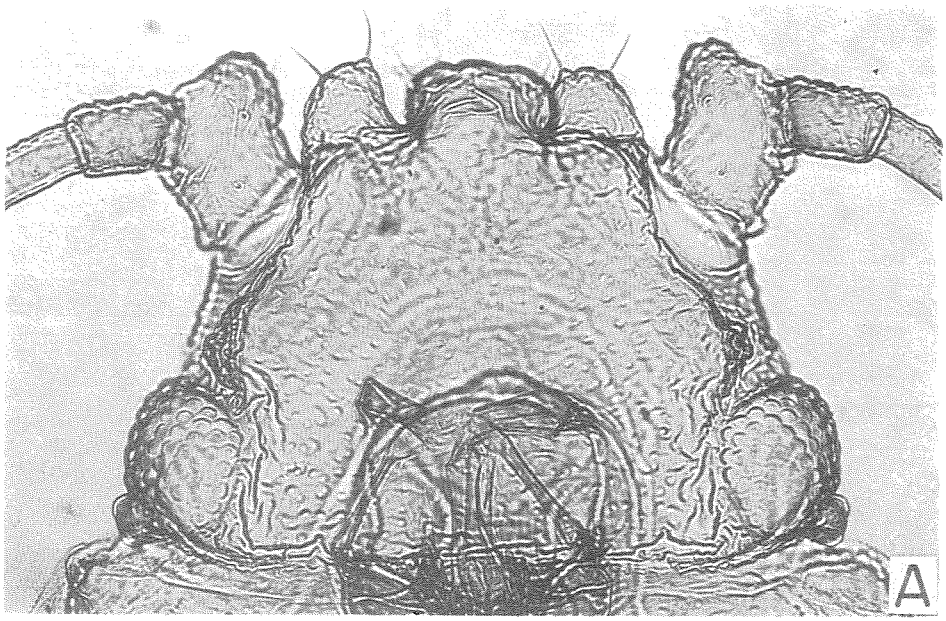

B

Plate VIII

Fig. 10. *Vesiculaphis angusticeps*, sp. n. Head (A) and caudal part (B) of the apterous viviparous female.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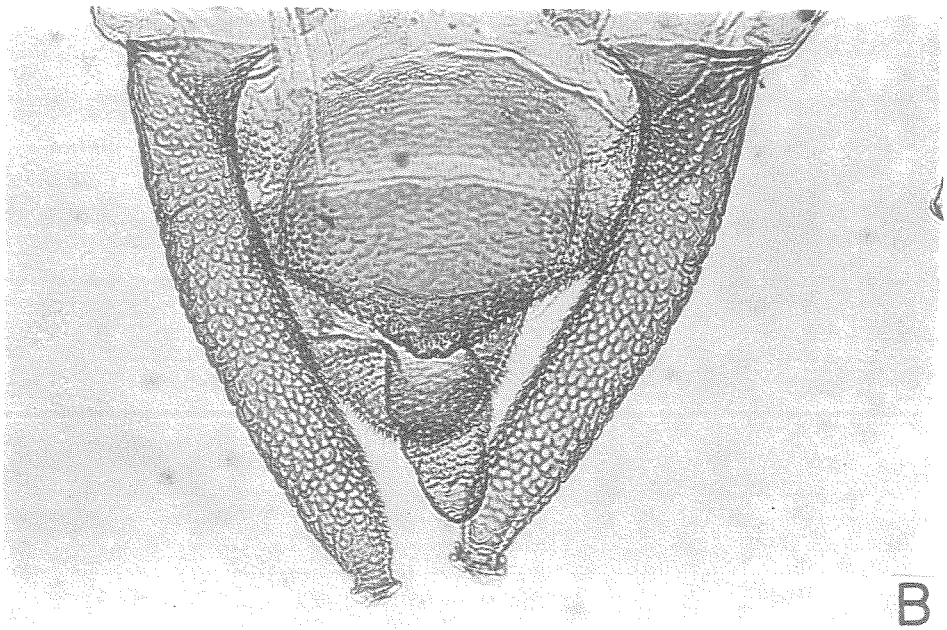
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